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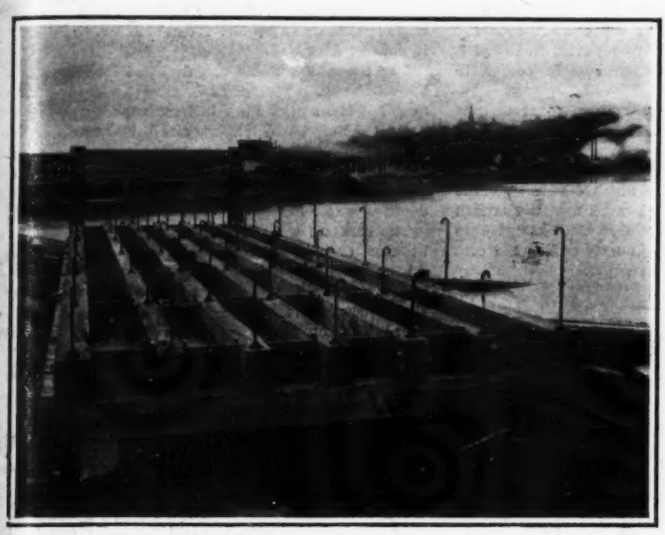


FIG. 1.—PONTOON METHOD OF SUBAQUEOUS CONCRETE CONSTRUCTION. THE TIMBER FRAME AND PLANK FLOOR.

FIG. 4.—A SECTION OF DOCK BEING FILLED WITH WATER AND READY TO PASS BELOW SURFACE.

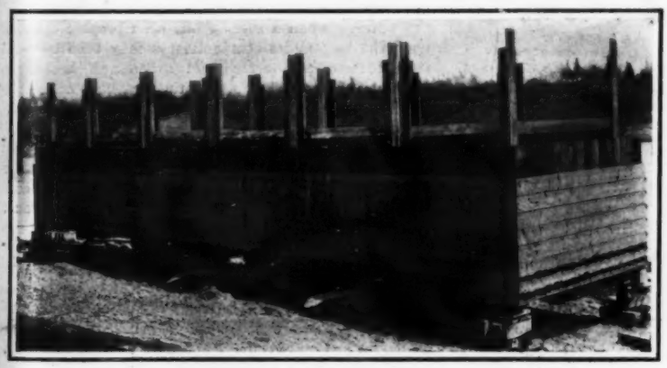


FIG. 2.—A COMPLETED PONTOON BUILT ON SHORE AND READY FOR LAUNCHING.

FIG. 5.—A SECTION OF DOCK WHICH HAS JUST STRUCK BOTTOM AND IS FILLING WITH INRUSHING WATER.

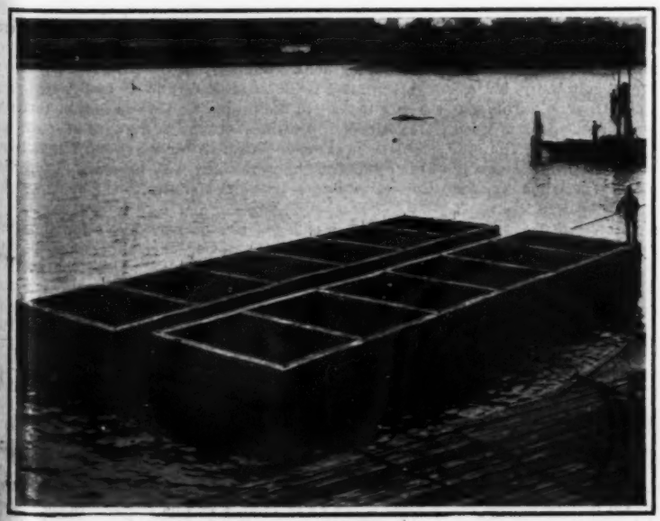


FIG. 3.—TWO SECTIONS OF CONCRETE DOCK READY FOR SINKING UPON A PREPARED BOTTOM.

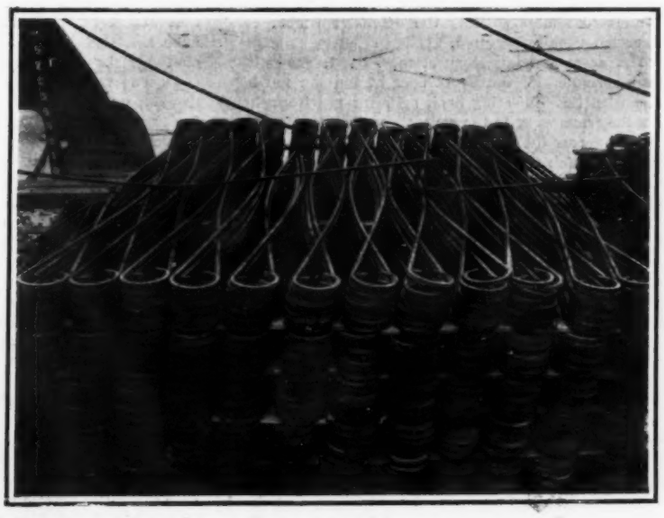


FIG. 6.—SQUARE STEEL REINFORCED BARS FOR USE IN PONTOON WALLS.

A UNIQUE PONTOON METHOD OF SUBMARINE CONCRETE CONSTRUCTION.

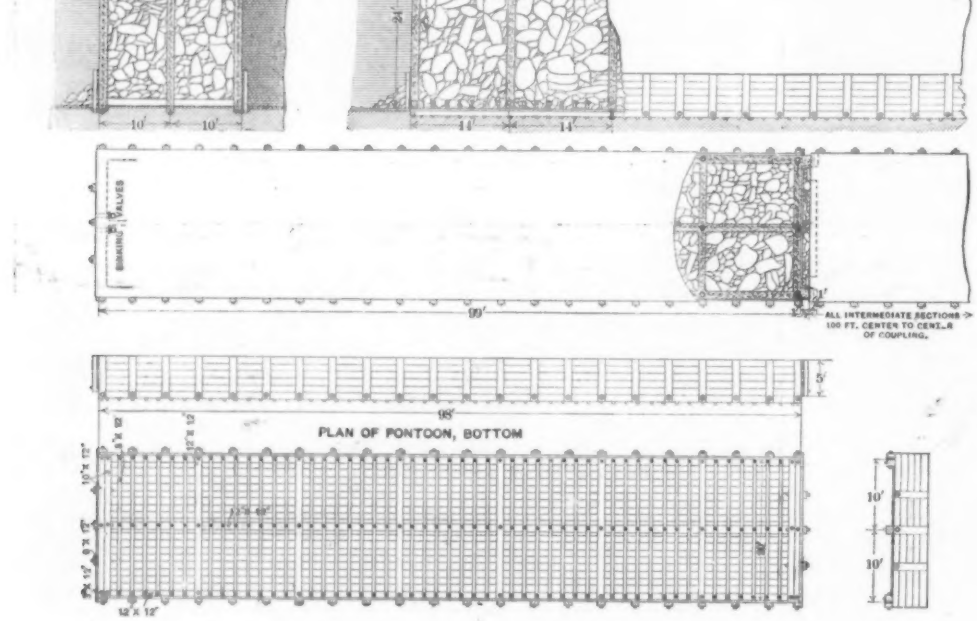
NOVEL SUBMARINE CONCRETE WORK.

A UNIQUE PONTOON METHOD OF CONCRETE CONSTRUCTION

BY FRANK C. PERKINS.

A most novel and interesting form of construction of a reinforced concrete dock is that of the Goderich Elevator and Transit Company at Goderich, Ontario, Canada. This subaqueous concrete construction is applicable to all classes of underwater structure, and is due to J. F. Tromanhauser, who designed the pontoons. They were built of reinforced concrete, floated across the bay half a mile, weighted with sand and rock, and lowered in position as indicated in the accompanying illustrations.

It is true that the advantages of concrete for use in subaqueous work have been long recognized, but the difficulty of cofferdamming, or of placing concrete under water, has limited the use of this material for such work. For some years it has been customary to build crib work within a foot or two of the low-water levels, to cap the timber with concrete, and then to carry the superstructure of concrete up to the required level. The method adopted at Goderich was to construct the concrete work above water, the wharf or foundations being completed in still water and kept dry until properly set. The sections were then floated into place, submerged, weighted, and the superstructure carried on above the water lines. This method eliminated almost entirely the extensive timber construction usually required.



DETAILS OF THE PONTOON METHOD.

The accompanying illustration, Fig. 1, shows the timber frame and the plank floor of the pontoon bottom with the projecting hook bolts for use in anchoring the framework to the concrete walls. In the background across the water may be seen a completed pontoon, in which the concrete walls are being built from a mixing plant on the shore. A completed pontoon built on the shore and ready for launching is shown in illustration, Fig. 2. It is made watertight for a height of about five feet, and measures 54 feet in length and 14 feet in width. Two completed sections of the concrete dock of the above dimensions, measuring 20 feet and ready for sinking upon the prepared bottom, which is brought to a level uniform surface before the dock is sunk in position, are shown in Fig. 3.

The sinking of these floating concrete sections or pontoons is done by filling the hollow compartments with water, as illustrated in Fig. 4, this photograph showing a section of the dock being filled with water and just about ready to pass below the surface.

It will be noted that as the top of the concrete walls are supposed to pass below water, planks were put on top of the walls to prevent too rapid an inrush of water after the walls have passed below the surface. The accompanying illustration, Fig. 5, shows a section of the dock which has just struck bottom and is filling with the invasion of water. It will be seen that the pontoon bottom was built deeper on the front side, so as to throw the dock with a slight incline toward the shore, to resist the pressure of the filling behind the dock on the land side. It will be noticed that one corner of the pontoon is visible, showing the outer side of the dock just level with the water or slightly under the surface, while the land-side wall has passed entirely out of sight.

The design and construction of the square steel reinforced bars for the pontoon walls may be seen in illustration, Fig. 6, these bars being built into the concrete walls in pairs just as represented in the pile, except that they are on 12-inch centers course to course.

Undoubtedly the many advantages of concrete over wood and steel for all classes of under-water construction are so apparent to a practical mind as to scarcely warrant mention here. It may be stated, however, that the principal points which demonstrate the superiority of concrete for such work are its strength and permanent durability, its absolute resistance to the destructive teredo worm, and its reasonable cost under proper methods of construction.

The hazard and difficulty of concrete construction under water by the old methods have been so great that engineers, while fully recognizing its qualities, have hesitated in its extensive use solely on account of the risks they incurred. Its use therefore for subaqeous work is not a matter of suitability, but entirely a question of practical construction. This difficulty removed, and concrete will soon displace wood in almost all important work of this class. The system of construction represented here is especially adapted, it is claimed by Engineer Tromanhauser, for use in all kinds of docks, piers, breakwaters, sea walls, cofferdams, lighthouse and dock warehouse foundations, and for many other purposes. Its application is almost unlimited.

The hazard of open sea construction is entirely removed, for the weight of the concrete itself when sunk without ballast is sufficient to safely withstand any reasonable sea that might break over the structure until ballasting is completed.

The concrete is all built and hardened above water, and the steel reinforcement is all imbedded in the concrete and protected from rust and corrosion. The timber frame of the pontoon bottom is a stiffening and a protection to the concrete walls, and on mud, clay or sand bottom will give practically a uniform bearing over the entire bottom surface. On rock or uneven sea bottom the depressions would be filled up with small stones and gravel to bring the bottom up to a uniform general level before sinking the concrete structure.

It will be noted that the concrete wall, being watertight, admits of rock, gravel, sand, or even clay ballast being used in the compartments, as the washing action of the sea would have no effect upon the interior of the structure. This condition largely reduces the cost of ballast, as sand and gravel can in many cases be dredged directly into the compartments at very low first cost.

A clear idea of the system and method of construction and its simplicity and easy practical execution, and one which must strongly appeal to all experienced engineers, is given by Mr. Tromanhauser, the designer in charge.

The pontoon bottoms are first built on shore, one bottom for each section of dock or breakwater as required. The sections are in lengths of about 100 feet each, but may be in longer or shorter lengths as conditions demand. The water-tight pontoons are launched and floated into a sheltered location convenient for building operations, but with sufficient depth of water for sinking while under construction.

The concrete walls are designed within the pontoon bottoms, each in uniform layers of about 2 feet deep. As the walls rise, sufficient rock or gravel ballast must be evenly deposited in the compartments to prevent the structure from becoming top-heavy and rolling over. The top of the hardened walls must, however, always be maintained above water level, so that the fresh concrete may set before being submerged, and also to prevent water flowing into the pontoon and sinking the entire structure. When the walls have reached a height of say 1 foot to 2 feet greater than the depth of water in which the dock or breakwater is to be sunk, during a calm sea the section is floated into position, and by the action of sea valves water is admitted into the compartments and the section sunk upon the intended side, the sections being coupled together properly while sinking.

In case a section should, for any reason, require adjustment after being sunk upon the bottom, it may be refloated by closing the sea valves and pumping out the water. When a section has been properly located upon the bottom its compartments may then be filled with ballast, and after final settlement has taken place on the sea bottom, the top or above-water portion may then be completed in perfect line and level.

This particular work at Goderich entailed the construction of a piece of dock 216 feet long. It was put together in four sections of 54 feet each, and all sections were 14 feet wide and consisted of six compartments, the center measurement of which was 9 feet by 14 feet. The dock was sunk in about 20 feet 6 inches of water.

The concrete was filled in at a rate of about 2 feet a day of 1:2:4 mixture. This was allowed to remain for twenty-four hours, when another 2 feet was added. No difficulty was experienced in securing water-tight walls. The weight of the concrete walls was sufficient to sink the pontoons, which were about 20 feet deep when completed. About 6 feet remained out of water.

It will be of interest to state that while the concrete sections were being constructed, the lake bottom was being leveled to receive them. The sections were then floated into position, lined, and filled with water, when they sunk gradually into position. They were partly filled with sand and gravel, and were then ready to receive the piling, which was driven through the wooden pontoon bottoms to the solid rock on which the sections rested. After the piling was driven, the compartments were completely filled with sand and gravel to give weight and stability to the dock.

Workmen engaged on the excavation for the new Rosenthal Building, Ottawa, unearthed an old well about 15 feet below the street level. The well, which had evidently not been used for many years, was probably dug by some early resident of old Bytown. It was situated directly under the east wall of the buildings that have been torn down to make way for the Rosenthal structure, and must have been in disuse for at least sixty years, as that is the reputed age of the buildings just razed. An old-fashioned suction pump, still in good repair, and the head of an ax, were found at the bottom by the workmen. The well was evidently the work of a skilled workman, for, despite the years since it was dug, the wall of rubble stone around the sides is still in fine repair. Some 6 feet through solid rock was bored by the early resident before he struck water, and to-day it is gushing up with probably as much energy as it did when first bored. One of the workmen sunk his crowbar down this depth before he struck bottom.

THE INCREASING SIZE OF STEAMSHIPS.

THE PROBLEMS OF BIG DISPLACEMENT.

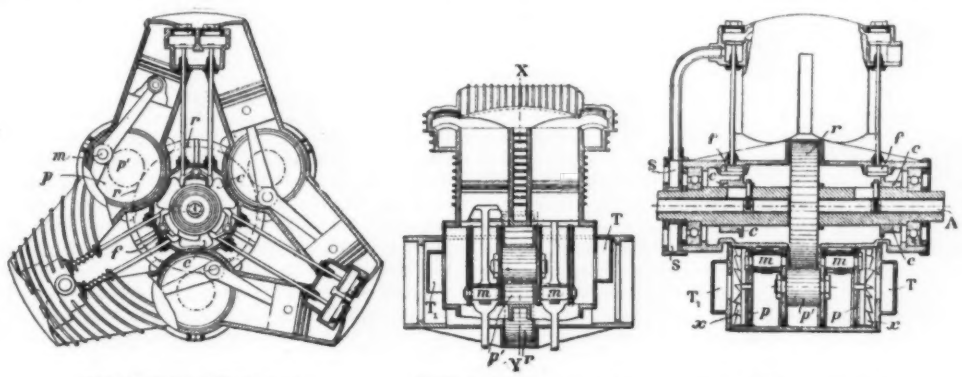
WHEN the "Lusitania" and the "Mauretania" were under construction they were widely known as "the new Cunarders," and as such they represent to-day the most perfect realization of mercantile naval architecture. But they are only 790 feet long and displace but 37,000 tons when complete with coal, cargo, and passengers at the beginning of a voyage. They are already exceeded in size by the huge vessels of the White Star Line, the "Olympic" and "Titanic," the first of which will be launched in October. These vessels are to be slower and will be about 840 feet long, but they do not attain the dimensions of the latest and largest vessel which is just about to be laid down by the Hamburg-Amerika Company. The White Star boats are to be about 48,000 tons displacement, but though the size of the German vessel has not yet been made officially public there is every reason to believe that she will be about 60,000 tons, and with the designed 80,000 horse-power will attain about 22 knots. The dimensions will be about 930 feet by 93 feet beam. It is as absolutely impossible to foresee, as it is useless to suggest, what the limit of size of vessels will be. Every possible indication of future development tends to an equal increase of size and speed in almost every class of vessel. Channel steamers ten years ago were under 300 feet long and seldom exceeded 19 knots. Now we have 370-foot vessels of 25 knots, and a large number of 350 feet and about 23 knots speed. In fast cruisers the increase has relegated to obscurity the "Warrior" class of 13,500 tons and 480 feet in length, seeing that the "Lion" class, which are less than five years newer, are double the size, nearly half as long again, and possess more than treble the power. In battleships, the "King Edward" class, launched in 1903 and 1904, are just about half the size of the newest ship ordered by a South American republic; while of torpedo-boat destroyers the same is also true, the displacement having been doubled in six years. It is, consequently, really rather disquieting to contemplate the possible developments of the next three or four years. No one can doubt that the size will increase enormously. The probable limiting feature, as far as can be seen, is rather one of draught of water than of beam of ship or length, and in the shallow waters which are found round the coasts of Germany and the United States, as well as in South America, this has been found a very serious matter already. Without substantially fluctuating from a more or less standard maximum normal draught of 27 feet water, the beam of battleships has gone up by about 20 per cent in the last five years. That of the "King Edward" was 78 feet, of the "Lord Nelson" 79 feet 6 inches, and "Dreadnought" 82 feet. The latest dreadnoughts are 88 feet 6 inches, but abroad this dimension is closely approaching 100 feet. The "Wyoming" class in the United States exceeds 93 feet, the German ships are more, the Argentine battleships are 96 feet, and the latest Brazilian ship is said to exceed 98 feet. Even the most conservative designer can hardly doubt that the 100-foot dimension will be exceeded in a year or two.

Shipbuilders, however, are apt to feel this increase less than dock owners. To the latter the prospect must be truly appalling. There are very few docks in the country that can admit 90-foot ships at all—there are very few, indeed, abroad. It is not likely that the floating dock will prove to be a solution of the difficulty, but these ships must be docked, and their accommodation needs immediate attention. Only a few years ago it was deemed sufficient to dock large vessels only once a year, but practical experience and Admiralty regulations now demand docking twice a year, and there is every probability that this will be still further reduced to a four-monthly period. The minimum margin between width of ship and width of dock can be taken as 2 feet a side. Even this is a perilously small amount, except in the finest weather, though no doubt exists that it will often be attempted. At Devonport there are four docks of 95 feet width of entrance. Portsmouth dockyard possesses only one of 94 feet, but the other five of 82 feet cannot take even the "Dreadnought," and Chatham has only one of 100 feet. That is to say, in all the Admiralty harbors, we are unable to drydock the "Wyoming" or "Moreno" classes, as well as the latest German vessels. Of course, except as a matter of courtesy, we shall not need to do so, but attention must be directed at an early date to our own requirements, and the question is of vastly more importance than we have yet perceived any responsible member of the government pointing out. Haulbowline and Malta each have one 94-foot dock; otherwise, with the exception of the relatively short—545 feet—floating dock at Bermuda, we are lamentably short of accommodation abroad. Among private docks, one at Avonmouth is 100 feet wide, the Brocklebank dock at Liverpool and Avonmouth No. 2 are both 96 feet, Birkenhead No. 7 is 95 feet, and the Canada dock at Liverpool is 94 feet. All these are a long way from the Channel, which is obviously the locality in which we require battleship accommodation more than anywhere, except perhaps on the East Coast, where only the Hebburn Graving Dock, of 90 feet width, is available, and this dock only possesses 28 feet 6 inches of water on the sill.

Besides width at entrance there is another very important matter to which the increasing displacement of all classes of vessels draws attention, and that is the strength of dock foundations. The larger vessels are not increasing in length as rapidly as in beam, and consequently the weight per unit of length is increasing simultaneously with total weight. The importance of having adequate strength of foundations has not escaped the designers and builders of drydocks, but the recent rapid increase of size, which cannot reasonably be expected to have reached even a temporary limit, obviously reduces the assumed factor of safety. It is quite evident that there exists an urgent necessity for taking early steps to modify our facilities for docking large vessels, especially in the South of England and on the East Coast, and not so much because of the present lack of large docks as because the outlay involved will be considerable, and also the time occupied during which even the existing facilities will not be available.—The Engineer.

THE BRETON ROTARY EXPLOSION MOTORS.

IN rotary explosion motors the cylinders and their pistons revolve about a fixed shaft. Inventors have long been at work upon motors of this class, but until very recently little success has been obtained. For use in airships and aeroplanes, the rotary motor possesses great advantages. Weight can be saved by the elimination of the fly-wheel, the regulating function of which is satisfactorily performed by the rotating cylinders and other parts. Furthermore, the cylinders are kept cool by their rotation, so that no ventilator or water-cooling device is required.



Vertical section perpendicular to fixed shaft. Longitudinal section of a pair of cylinders. Vertical section along axis of fixed shaft.

THE BRETON ROTARY EXPLOSION MOTOR.

The successful flights made last year, especially at the Rheims aviation contest, by aeroplanes driven by the "Gnome" rotary explosion motor, have reawakened interest in motors of this class, and several new types were shown at the aeronautic exhibition in October.

The Breton motor, one of these new types, is here described and illustrated. It has twelve cylinders and may be regarded as a pair of six-cylinder motors, rotating about the same shaft. The piston rods of the six cylinders of each group are connected, in pairs, to three crank pins, *m*, borne by three disks, *p*. Between each of these disks and the corresponding disk of the other group of cylinders is a pinion, *p'*, which is rigidly attached to the disks and engages with the teeth of a wheel, *r*, attached to the fixed shaft, *A*. Each pinion, therefore, is driven by the pistons of four cylinders, i. e., two cylinders of each group, and the three pinions revolve round the fixed wheel and shaft, carrying the carter and the twelve cylinders with them. The admission and exhaust valves of the cylinders are operated by the rods *f* which, as the carter rotates, encounter the cams, *c*, attached to the fixed shaft. The explosive mixture is drawn from an annular chamber, *S*, which communicates with the carbureter. The internal parts are cooled by air, which is drawn from the chambers *T* and expelled into the chambers T_1 by the action of ventilating blades, *x*, attached to the crank plates, *p*. The diameter of the pinions is one-fourth of that of the fixed wheel, *r*. Hence the cylinders and carter make only one revolution for each four revolutions of the crank plates. This reduction from 1,200 or 1,600 to 300 or 400 revolutions per minute facilitates lubrication and makes it possible, in many cases, to couple the motor directly to the machine to be driven.

The ignition is furnished by a magneto which revolves six times as rapidly as the motor. A commutator attached to the carter connects the magneto successively with each of the six igniters. (One igniter, one admission valve and one exhaust valve serve for each pair of parallel cylinders.)

One form of the Breton motor has no carbureter, but the seat of each admission valve is traversed by a small tube, connected with a pump, which is operated by the motion of the valve and injects gasoline and aspires air in accordance with the position of the valve. This motor is regulated by moving the cams which govern the movement of the valves.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Le Genie Civil.

NORTHERN ALASKA.

LAST season an exploratory survey was extended westward from the lower Yukon to Seward Peninsula. This year it is proposed to carry a similar survey northward from the bend of the Koyukuk to the Kobuk and thence southwestward to Candle, in Seward Peninsula. This expedition will not have time to gather much detailed information, yet it is expected to procure sufficient data for a general geologic and topographic map which will be of value to the prospector. This party will also make an investigation of the Kobuk River placer district. The Kobuk was surveyed by the Geological Survey in 1901, but has not since been visited by any member of the Survey. This work will be done by P. S. Smith and H. M. Eakin, geologists, who will go inland by the Yukon to the Koyukuk.

In a report to the Corporation of Birmingham, Sir Oliver Lodge deals with the danger from lightning to which the various dams and buildings of the Elan Valley Waterworks are exposed, and sets forth in each case proposed protective arrangements. An introductory portion points out the danger arising from the mechanical shocks that occurs when lightning discharges into water from a conductor with inadequate surface in contact, and also the danger of explosion in the interior of a dam, if lightning were metallically conducted there, and then found no sufficient means of escape. Protection therefore involves either keeping the lightning to the surface, or if it is allowed to penetrate, giving it plenty of metallic surface by which to reach the water in a quiet and unexplosive manner. The former of these principles is that mainly applied in the proposed plans for protecting the various towers. The towers or buildings, it is suggested, should be provided with partial or complete encagements of metal or copper strip, which present numerous points to the sky, and extend or are connected directly with submerged horizontal belts of copper sheet provided with numerous points. Owing to the variation of the level of the lake, an alternative "earth" is suggested, consisting of a moored floating buoy, with a copper rope connection coming up through the water. This buoy is to have a horizontal sharp-edged rim with points all round on a level with the water.

HOW FISH ARE HATCHED.—IV.*

FISH-CULTURAL PRACTICES IN THE UNITED STATES BUREAU OF FISHERIES.

BY JOHN W. TITCOMB, ASSISTANT IN CHARGE OF THE DIVISION OF FISH CULTURE.

Continued from Supplement No. 1810, Page 164.

Taking and Hatching the Eggs.

Seining operations and spawntaking at California stations.—At the Baird station all the salmon are caught by seine with the exception of a very few taken in the trap in the upper rack. Owing to the swift current and the formation of the river banks the seine is always landed at one place, the rope attached to the upstream end being hauled by steam engine and the lower or downstream rope by a whim operated by horse-power.

When a haul is to be made the seine is carried by boat upstream about 50 yards from the landing before it is paid out from the shore. The downstream rope is paid out automatically as the boat moves, and is passed through a snatch block to keep the current from closing the ends of the seine until opposite the landing place, when both ends are drawn in at the same time. As soon as the seine has been laid out above the pool the engine is started, drawing the seine downstream toward the landing. When the last of the seine is in the water the whim is started and the lower end is also hauled down and in. A landing having been made, the ends of the seine are secured to pieces of rope fastened to pins driven into the ground. Hooks on loose ends of these ropes are slipped behind the corks of the seine. A trestle is placed under the rope to hold the cork line high above the water and thus prevent the salmon from leaping over it. The lead line is pulled upon the bank and thrown over iron pins to keep it from slipping back into the deep water.

The ends having thus been fastened, all the men are free to handle the fish, which must be quickly removed to prevent injury from crowding, this being especially true of the summer run when the water is warm. The men stand in the water and lift the fish from the net one by one until all have been looked over, handling them with the aid of heavy woolen gloves, and grasping them by the tail with the left hand while the right is placed just behind the pectoral fins. A gentle pressure of the fingers at this point forces out a few eggs if the fish is ripe; if not ripe it is thrown over the seine into the river. When a ripe female is found it is carried to the pens beneath the spawning platform a few yards distant, care being taken to hold it vent side up to prevent loss of eggs. The males are handled in a similar manner, the ripe ones being placed in pens near the females.

The seining crew are likewise the spawntakers, and after two hauls in the morning they strip the fish caught the day before. The ripe salmon of each day's catch are thus held over as a precaution against any possible immaturity of the eggs.

On the spawning platform is a frame 6 or 8 inches wide, with sides converging toward the bottom and open at one end, into which a spawning pan can be slipped. The pan is rectangular in shape, about 6 inches wide and 14 inches long, with slanting sides and flaring ends. This shape is preferable to the round pan because of facility in washing the eggs, it being possible to dip a thin stream of water into the pan the entire length of one side. The frame holds the pan secure and at the same time its slanting sides assist in guiding the eggs into the pan.

After washing, the eggs are placed in 6-gallon spawn buckets which have previously been filled with water. These buckets are made of galvanized iron, with a wire-cloth strainer inserted near the rim to permit the escape of surplus water as eggs are added; they are painted inside with asphaltum, and are provided with covers. With the eggs in them they are placed on a platform which is built under water at sufficient depth to submerge about two-thirds of the body of the bucket, and thus maintain a proper temperature during water hardening. It is an essential feature of this platform that it be entirely independent of the spawning platform in construction. The period between the washing and hardening of the eggs is a critical one, and if they are jarred or disturbed there will be consequent greater loss in the hatchery.

FIG. 29.—EQUIPMENT OF McDONALD AUTOMATIC TIDAL BOXES FOR HATCHING COD, BOOTHBAY HARBOR, ME.

Shows boxes lifted out of troughs and bottom upward on farther tables. The bottom is of scrim. Eggs receive supply of water through the scrim bottoms of the boxes; also through small hole in one end of box. The distinctive feature is automatic siphon outflow.

FIG. 30.—BERRIED LOBSTERS.

Taken from pound at Boothbay Harbor station (Maine) in course of transfer to wells of the steamer which is to convey them to the hatchery for stripping.

In the spawntaking operations five or six male fish are first dipped from the pen and dropped on the floor, where they are allowed to lie until they stop struggling and may be more easily handled. The several females are dipped out, killed by a blow on the head with a piece of iron piping, and laid in the dead box. The bottom of this box is inclined and has a narrow slit at the lower end, through which any eggs that may escape from the fish will fall into a pan underneath, where they will be fertilized by occasional applications of milt. The dipping and killing continues until all the fish are stripped, males always being kept on the floor in order to have several ahead of the spawntakers. After being stripped the best-appearing males are returned to the pens where they usually recuperate and are again used to supply milt.

The female fish is grasped by forcing the fingers through the gills and the thumb into the mouth, the hand being protected by a stout leather glove. The man who does this, the headholder, stands, holding the fish vertically. The spawntaker, in a kneeling position, seizes the fish by the tail, bending its body over the pan, while with a sweeping motion he makes an incision in the thin side of the belly beginning near the pectoral fins and extending to the anal. The incision is usually made with a pocketknife, the blade being held between the thumb and index finger within one-half to three-fourths inch of its extreme point to prevent cutting too deep. Most of the eggs follow the knife and fall into the pan, the remaining ripe eggs being released by running the fingers into the body cavity. As soon as the eggs begin to flow into the pan milt is forced over them and they are stirred by the spawntaker with a few movements of the hand. They are then passed to the washer. The milt of one male may serve for several pans of eggs, but it often happens early in the season that several males are required to one pan.

As soon as the washer receives the pan of eggs he dips the edge of it in the river, the inflowing water causing the eggs and milt to boil up. The eggs at once settle back and the milt is poured off over the side of the pan. Ordinarily two such dips suffice to clean the eggs, after which they are poured into spawn buckets, and at once settle to the bottom, the surplus water escaping through the wire-cloth strainer near the top. Spawning operations usually

* Address before the Fourth International Fishery Congress, held at Washington, D. C., September, 1908.

consume about an hour. After water hardening the eggs are carried to the hatchery, about 200 yards distant, and turned over to the hatchery crew.

The spawning operations at Battle Creek and Mill Creek are practically the same as those at Baird, and the seining differs only in minor details to meet local conditions.

FIG. 31.—BOX OF TROUT EGGS JUST OPENED.

Showing ice hopper at left, stack of trays which have been taken out of the moss in center of box, and one tray with covering of mosquito net and moss removed. This is the common method of packing for ordinary shipments.

The method of taking eggs by incision has many advantages over the older practice of expelling by hand, chief among them being the larger number of good eggs secured and the higher percentage of impregnation. There is also a great saving of time and labor, and as all of the Pacific salmons die after once spawning, the killing of them in the process of taking the eggs merely hastens the end, and constitutes no loss of adult fish.

The eggs of the Pacific salmons are comparatively large, ranging in diameter from one-fourth inch for chinook to one-fifth inch for sockeye. Fortunately, however, these large eggs do not require the same treatment and care as do those of the other Salmonidæ, but may be placed 12 to 20 deep in wire-cloth baskets, 30,000 to 50,000 to the basket, water temperature being an important factor in deciding the quantity. The baskets, rectangular in shape, conform in width to the troughs; the latter are of the Williamson type (up-current), the flow of water to each trough varying with local conditions at the different hatcheries from 8 to 20 gallons per minute.

Local practices in different regions.—Experience seems to indicate, with regard to the sockeye, or red salmon, that there is an advantage in bleeding the fish before stripping, thus obviating a flow of blood with the eggs when the incision is made. It is therefore now customary at sockeye stations to decapitate or else cut off the tails of the female fish as the first step in the spawn-taking process. At Baker Lake, Washington, the practice is as follows:

The fish, which have been brought to the pens usually the day previous, are dipped out one by one, decapitated, and dropped upon a draining rack, where water is thrown over them to cleanse them for handling by the spawn-taker. The latter impales the fish on a short spike conveniently located to hold them over the pan while he makes the incision and removes the eggs. Two men are occupied in the work so far. A third fertilizes and washes the eggs, then conveys them to the hatchery. A million eggs may be secured in this manner in one forenoon by one such crew.

Although not suitable for canning or for the market, the sockeye at this period is edible and many are taken by local residents for food. Indians camp at some of the stations and preserve large numbers of the salmon. The majority of those killed, however, go to waste. At the Battle Creek station in one season it is not an unusual thing to bury during the spawning season 15,000 to 20,000 pounds of fish.

A convenient and economical method of separating dead eggs of salmon from living ones is the use of a salt solution.* If a basket of eggs is emptied into the solution, the unfertilized and dead eggs rise to the surface, where they may be quickly skimmed off. The method is not applicable in the manipulation of small quantities of eggs, but is very useful when, for some cause, there is an abnormal loss. It has not been successfully extended to the eggs of species other than the chinook, silver, and humpback salmons.

At the Baker Lake station, operated primarily for the propagation of the sockeye salmon, both sockeye and silver salmon are captured by means of a pound net as they enter the lake, but as the fish are not ripe at this stage of their upstream passage it is necessary to hold them until the spawning season. For this purpose a slough or bay at the head of the lake has been inclosed by racks and webbing to make a pound about 20 feet wide and 500 feet long, with an average depth of 6 feet. The entire bottom area is of soft mud; in it are two hollows of a maximum surface area of 300 feet and 400 feet, respectively, where the water is approximately 12 feet in depth. The water supply, from 800 to 2,400 gallons per minute, is derived from several small mountain creeks fed by glaciers and snow, and from springs.

This has proved an ideal place in which to hold salmon while their eggs are maturing. As many as 8,000 fish have thus been confined for thirty days and 6,000 for three months. After remaining in the inclosure for three or four months the fish are as clean and free from abrasion as fish that have not been penned. A noticeable fact, however, is that very few of these salmon ripen until October or November, while in previous years the spawning season has occurred during September and before October 15. The difference is attributed to the low temperature of the water in the inclosure, which remains from 6 to 8 degrees below that of the natural spawning beds of the lake. (During the summer the average water temperature on the spawning beds is about 56 deg.) The success of the impounding of the salmon is attributed to the low temperature of the water.

Silver salmon, as well as sockeye, have been successfully impounded at Baker Lake. A few impounded chinook, however, fungused rapidly, and after three weeks usually died before the eggs were taken.

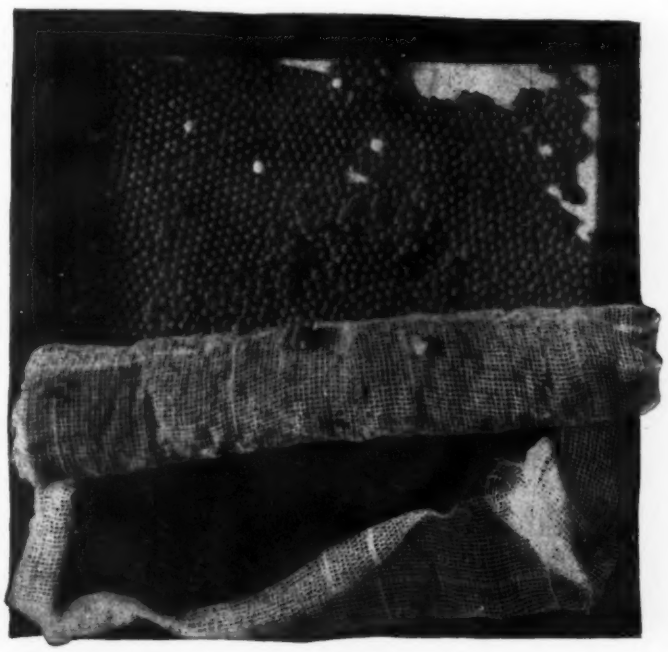


FIG. 32.—TRAY OF TROUT EGGS WITH MOSQUITO NET AND MOSS IN WHICH PACKED.

MARINE FISH CULTURE.

Cod, Pollock, and Flatfish.

On the New England coast the Bureau maintains three stations, for the hatching of marine fishes and the lobster.

Of the fishes the cod is first in importance. Its cultivation consists principally in hatching eggs obtained from market fish, the fish being stripped either by the fishermen or by the Bureau's spawntakers. The latter are daily distributed among the fishing vessels for the double purpose of stripping ripe fish as fast as hauled aboard and of collecting and caring for all eggs the fishermen may have taken. Coming as it does during the winter months, from early December to March on the Massachusetts coast and extending through March and April on the Maine coast, the spawning season is a trying one for the spawntakers, who must share many of the dangers and hardships of the fishermen.

At the Woods Hole station advantage has been taken of the presence of a large salt-water reservoir under the hatchery to test the Norwegian method of obtaining eggs. By this process adult fish are penned and allowed to spawn naturally. The eggs float to the outlet, where they are caught in a receptacle placed for the purpose, and thence are transferred to the hatching boxes. It has been demonstrated that a larger percentage of fertilized eggs per fish can be obtained thus than by the former method of stripping penned fish. The increase is not due to a higher percentage in fertilization, but to the fact that in the case of the penned fish there is an almost unavoidable loss of eggs extruded in the crates. Both of these methods are an improvement over nature, in that the eggs are protected from the time of extrusion until they have hatched and the surviving parent fish are returned to the ocean. This is fish culture in the usual sense and not purely conservation of an otherwise waste product, as is the collection of eggs from market fish.

Prior to the spawning season for cod, or from the middle of October to the latter part of December, spawntakers are distributed among the pollock fishermen, and from the eggs thus collected many millions of pollock fry are hatched and distributed annually.

The cultivation of flatfish is conducted on a more extensive scale than any other marine fish-culture work. The adult fish are taken from the fyke nets in which captured, usually the Bureau's own, directly to the hatcheries, where they are placed in tanks and held until they have spawned, the eggs being removed daily from the tanks to the hatching apparatus. It is possible to spawn flatfish artificially, and eggs are sometimes obtained in that way.

Lobsters.

Lobster culture also, as conducted by the Bureau, effects a saving of an otherwise lost resource, berried lobsters purchased from the fishermen furnishing eggs for the hatchery and being later returned to the ocean. At the Boothbay Harbor, Me., station the parent lobsters are held until the eggs are ripe in a pound similar to those used by the lobster men; and as it has been found that eggs taken late in the fall or early winter do not hatch successfully, one such pound is utilized to hold some 10,000 or 12,000 lobsters throughout the winter. The losses of lobsters during the period of confinement are only normal, and the quantity and quality of the eggs are superior to those obtained from freshly caught stock. It is noticeable also that the eggs of the impounded stock hatch almost

*O'Malley, Henry: Salt solution as an aid to fish culture. Transactions of the American Fisheries Society for 1905, p. 49.

simultaneously and somewhat earlier than those from freshly caught lobsters, undoubtedly because of the warmer, shallow, inshore water. By the middle of April the eggs are sufficiently well advanced to be removed from the parent and put up in the hatching jars; and as at this time the lobsters become quite active in a rising water temperature it is quite important that they then be removed to avoid serious losses from mutilation.

The removal of impounded lobsters is effected at low tide, the flood gates being opened and a portion of the water drawn off with care to retain enough water to protect the lobsters from exposure. Men in dories then go about the shallow portions of the pound picking up the lobsters on ordinary clam forks or hoes, the sharp teeth of which have been blunted. It was formerly the custom to use a drag seine for gathering the lobsters, but taken in such quantities they mutilate one another, and it has been found preferable to remove them by hand. After a portion of the stock has been removed the water is drawn still lower, until finally only a small area of the pound is flooded, and the remaining lobsters are removed.

As it has not been possible to transport lobster eggs successfully when detached, the berried females are always taken to the hatchery to be stripped, the transfer being made in the wells of fishing smacks or the Bureau's vessels. From this time to the close of the season in July berried lobsters are collected from the fishermen and transferred to the hatchery to be stripped. Immediately after the close of the season the collection of fresh berried lobsters for stocking the pound is begun and continued into November.

It is unquestionable that the impounding of lobsters as practised in Maine is superior to any other present method of holding the adults for a length of time. The character of the Maine coast, with its numerous natural inlets and its unusual rise and fall of tide, affords especial advantages for the use of pounds. When these conditions do not exist, however, recourse can be had to cars, although data thus far obtainable fully demonstrate that a large number of lobsters can be held for a longer time and with a smaller percentage of loss in pounds than in cars.

Contrary to the custom of the pound fishermen, the ice on the surface of the pound operated by the Bureau of Fisheries is removed from time to time during the winter, with the result that a much larger percentage of lobsters is found in the spring. It has been observed that the rising and falling of ice with the tide frequently crushes lobsters that happen to be in the shallow water near the edges of the pound, and removal of the ice at intervals obviates this difficulty.

Experiments have been made as to the poundkeepers' practice of inserting wooden plugs in the claws of penned lobsters to prevent their mutilating one another. For lobsters intended for market the procedure seems suitable, though it results in an unsightly discoloration of the muscles. There seemed to be a question, however, whether it would be feasible with the impounded stock of the Bureau destined for liberation in the open waters after removal of their eggs. The experiments showed that out of 2,110 lobsters removed from the pound, all of which had been plugged when put in, 742 had lost both plugs, 563 had lost one plug, and 605 retained both. The warm weather when they are first confined, however, is their most active period, when the plugs do most good. Mutilation is thus prevented and the plugs apparently work no permanent injury to the lobsters.

It is important in the impounding of lobsters to take precautions, so far as possible, for the exclusion of eels, which have an especial liking for the eggs and will strip a female lobster in a very short time. Even with all precautions it seems impossible to exclude eels entire; it is probable that many enter when small and grow up in the pound.

The rearing of lobster fry to the fourth molt, as practised by the Rhode Island Fish Commission and so admirably set forth in a paper read at the congress,* has not as yet been taken up by the Bureau, but it is doubtless feasible at the Boothbay Harbor station. Before the first experiments in this direction at Boothbay it was thought that owing to the lower temperature of the water in this more northern latitude the periods of molting would be prolonged and the feeding and care of the fry consequently attended with abnormal losses. It has since been found that this difficulty can probably be met by installing the rearing plant in a lobster pound, where the temperature is higher and more even than in the open waters. The Bureau therefore hopes to enter upon this undertaking in the near future, for the purpose of rearing a portion of the lobster output. To attempt to rear to the fourth molt the entire product of the Boothbay station would involve an expenditure far beyond present financial resources.

MEASURING AND COUNTING FISH EGGS AND FRY.

Immediately after water hardening, for a short period varying with the species and water temperature, the careful handling of fish eggs is not injurious. During this period their numbers may be very definitely ascertained by the use of any receptacle suitable for a measure, the capacity of the receptacle having first been ascertained by counting the whole or a fractional part of its contents.

For eggs of the trouts and those of small size an apothecary's graduate or the ordinary graduated quart or pint measure is commonly used. For large quantities the long-handled dipper used in transferring them to the hatching apparatus may be advantageously utilized. As many eggs as possible are poured into the measure, nearly all of the water being forced out over the rim.

Unless the eggs are to be transferred to a hatchery beyond the jurisdiction of the shipper, the eggs may not be measured until a more convenient time, it being possible from long familiarity with the capacity of the apparatus in actual use to estimate quite accurately the number of eggs on hand at any time. Provided they are spread uniformly, the number of eggs to a square inch is a fairly accurate basis for ascertaining how many eggs are on each tray. Some fish culturists prefer to ascertain the actual number of eggs on hand by weighing them after having determined by actual count the basis for such calculations.

These methods are especially applicable to the heavy eggs of the Salmonidæ, and may be employed not only after water hardening, but also at any stage of incubation after the eggs are eyed up to a day or so before hatching, at which last stage a measurement closely approximates the number of fry that will be in the subsequent hatch.

Eggs hatched in jars are usually measured by means of a graduated scale in the form of a square made of wood, the units indicated on the long leg of the square. The square is adjusted to the jar as shown in Fig. 9. The scale reads from the bottom line upward, the first or bottom line being at a height corresponding to the level attained in a jar by a measured half pint of water, and each line represents the number of eggs of a given species as established by actual count from a measured half pint. The dead eggs will have been from time to time siphoned off and when the remainder are fully developed or about to hatch the scale is applied to each jar and a very careful measurement is made to ascertain their number. The number of fry available for distribution will be approximately the number of eyed eggs in the jars just before hatching, as the mortality after this stage of development is usually inappreciable.

A novel method of obtaining the number of eggs in a given lot has lately come into use, and as the work can be done without counting a large number of eggs, has proved especially valuable in dealing with eggs of small size at field stations where no measurements have been established. This method, devised by Mr. H. von Bayer, architect and engineer of the Bureau, employs a gage which quickly gives the diameter of the eggs, knowing which it is possible by reference to a diagram to determine at once the number of eggs to the quart.*

In the keeping of accurate hatching records it is important that the basis for computations be ascertained immediately before any general measuring methods are applied because it is well recognized that eggs of most species vary in diameter with stock from different waters and that eggs from any given collecting station vary at different periods of the spawning season, those taken at the height of the season being larger and more uniform than those taken earlier or toward the close of the season. For instance, brook trout eggs taken at a particular station may run 250 to the fluid ounce during the height of the season, while the first take may have run 300 to the ounce and the last eggs of the season may average 400 or more to the ounce. These variations make it necessary frequently to establish a new measure for ascertaining the actual number of eggs. There is also to be taken into consideration the fact that eggs of almost all fishes increase in size from 4 per cent to 15 per cent according to the species, from the time they are water-hardened up to the time they are about to hatch.

This fact, coupled with the fact that eggs of the same species vary in size at different sources of supply and periodically at the same source of supply, is a point in favor of the von Bayer method of computing the numbers of eggs of small diameter.

Sac-absorbed fry and advanced fry of the trouts, landlocked salmon, etc., may be measured in the same manner as are the eggs—in an apothecary's graduate or other container, straight vertical sides being preferable to the flaring sides of the ordinary glass graduate. The ordinary graduated half pint or pint cup used by cooks is a very convenient measure. The fry are poured in until the measure is overflowing with them to the exclusion of practically all the water, the filling and emptying being done quickly. Actual count of the number in one measure establishes the basis for computation. The growth during this period being very rapid, however, a new unit must be determined daily.

The number of fingerlings are ascertained by actual count of each lot as dipped a few at a time from trough to transportation can or other receptacle by means of a small hand net of tightly stretched bobbinet.

TRANSPORTATION OF EGGS.

To equalize and facilitate the work of the hatcheries it is customary to transport, sometimes to considerable distances, both green and eyed eggs from one station to another, thus effecting the distribution of fish through the distribution of eggs. Several auxiliary stations are maintained on the Great Lakes solely for hatching eggs received from Northville, it having been found economy to transfer to them as eyed eggs the portion of the Northville station output destined for distribution to waters in those localities. Both green and eyed eggs are also shipped to State hatcheries, and the latter to foreign countries.

The methods of conveying green eggs from the field where collected vary to suit conditions. The stations at which eggs of commercial fishes are hatched in large numbers are usually located conveniently to the source of supply so that it is possible to carry the freshly fertilized eggs to them in the pans, buckets, or other receptacles which constitute the equipment of the spawn-taker. It often happens, however, that the eggs must be held in the field or be in transit for two or more days, and in such cases a packing case is employed.

USUAL STYLE OF PACKING CASE.

For ordinary purposes a packing case consists of a wooden box which will accommodate a stack of trays and an ice hopper, with 2 to 4 inches of insulation or packing on all sides and under the tray stacks. The frames of the trays are made of light, soft wood, usually white pine, ⅝ inch by ⅞ inch or ⅞ inch by ¾ inch, over which is tightly stretched a bottom of canton flannel, nap side up, or of heavy cheese cloth, with perforations in the cloth to facilitate the passage of water.

For long-distance shipments it is customary to make the bottoms of the trays of wire cloth painted with turpentine asphaltum, over which canton flannel or cheese cloth may be spread before putting the eggs upon them, and a thin layer of moss under the cheese cloth in addition is advocated by some fish culturists. The soft spongy bed of moss prevents concussion in handling and retains moisture, while at the same time it allows a sufficient circulation of oxygen and free passage for water from melting ice, etc. For very long or warm-weather shipments it is sometimes advisable to use a case with double sides, with insulation between, the space between the inner case and stack of trays being filled with ice.

The ice hopper is about 3 or 4 inches deep, of the same length and width as the tray frames, and rests upon the top of the stack. Its bottom is perforated to allow a drip from the ice through the trays and thus keep the eggs constantly moist and cool. Double cases, the length twice the width, arranged for two stacks of trays side by side with a partition between them, are sometimes used in the Pacific salmon work.

The fish culturist often works in isolated places and must use the material which is most accessible and economical. Moss is therefore very generally used for filling the space between the stack of trays and the packing case; mineral wool, leaves, sawdust, and shavings also serve the same purpose, though with ice in contact with the inside lining of the outside case mineral wool is objected to because when damp it has a tendency to sag. Any of these materials may be used for insulation in the long-distance cases. Cork board insulation, also, is very efficient and of lighter weight than the others, but it has not been tested so fully as have shavings, at present the material most popular with caretakers.

The cover to the case may be screwed on, but for shipments requiring the renewal of ice it is customary to provide a hinged cover with hasp and staple.

(To be continued.)

After being under construction for about ten years, the new waterworks of Vienna are nearly completed, and will be opened at the end of this year. Supplies are derived from mountain springs and brought to the city by an aqueduct 113 miles long, built mainly of concrete and measuring 6 feet 10 inches high by 6 feet 3 inches wide. Numerous tunnels have been driven on the line of the conduit, one of them at Göstling being 3 1/3 miles long, while the total length of the tunnels aggregates nearly 53½ miles. As a general rule, valleys have been crossed by syphons with the collective length of 13 miles, but there are also about 100 bridges accounting for some five miles of the aqueduct. The new aqueduct will bring into Vienna an auxiliary supply of more than 50 million gallons daily, which will certainly be a most welcome addition to the yield from the existing works, whose output ranges from 35 million gallons down to 26 million gallons a day, according to circumstances.

* Mead, A. D.: A method of lobster culture. Proceedings Fourth International Fishery Congress, Bulletin of the Bureau of Fisheries, vol. xxviii., 1908, pp. 219-240, pls. vii.-xi.

* Von Bayer, H.: A method of measuring fish eggs. Proceedings Fourth International Fishery Congress, Bulletin of the Bureau of Fisheries, vol. xxvii., 1908, pp. 1009-1014.

THE AEROPLANE IN WAR.

ITS POSSIBILITIES AND IMPOSSIBILITIES.

IN the Kriegstechnische Zeitschrift appears an article by an anonymous writer, presumably a military officer, on the military application of the flying machine.

It is definitely stated that flying machines will be used in some future war, possibly within the next ten years, the author of the article hazards. But to what extent they will be so used and for what purpose is not altogether clear. The author of the article in question believes that the flying machine will be used in war primarily for scouting. For reconnoissances at great distances from the main body of troops, the airship must be used because of its greater radius, and the aeroplane will probably become the auxiliary of the airship. It is suggested that until the enemy is actually sighted, a flying machine may be towed by an air cruiser, in which case it naturally must be secured in such a way that, while prevented from tipping accidentally, it is ready for almost instant flight. The mere act of casting the machine loose must launch it, and the motor must be started during the glide immediately following. As soon as the first important observations of the enemy have been made from the airship, the aeroplane is dispatched to headquarters with that information, the airship remaining for further study of the enemy's position. The aeroplane must therefore have a minimum radius of 60 miles in order that the dispatch may surely reach the commanding officer (particularly if his forces are stationed at a great distance from the enemy.) Automobiles or flying machines can receive the dispatch at specified points and relay it to headquarters.

The airship is to be used only if the enemy is at a great distance, and then chiefly by large bodies of troops. Small bodies must rely solely on the flying machine because it is more easily transported. Launched at daybreak, such a flying machine can soar in advance, and in a moderate wind easily reach an enemy distant not more than 30 miles. From a height of 1,500 feet the pilot commands an excellent view of the hostile troops. He will therefore be able to perform his work much more quickly and thoroughly than a company of cavalry. Although experiments have been made to communicate by airship with a central military station by wireless telegraphy, it is doubtful if wireless telegraphy can be counted upon in the case of the aeroplane for many years to come. Still the aeroplane travels at such high speed that in the space of three-quarters of an hour it should be able to return to the commanding officer with full information. If the weather is favorable a general should know in less than two hours after having sent forth his aerial scout, the position and strength of his enemy. By the time the aeroplane is sent off again for further reconnoitering, the enemy may have approached so far that the scout can return in even shorter time.

During the progress of a battle the aeroplane should be able to perform valuable services both in defense and attack. The position of the enemy's troops and their every movement will be to the aerial scout as an open book. Nothing will escape his trained eye, not even concealed batteries, or changes of position of any body of men or the effect of artillery fire on hostile defenses. But such an aerial scout must above all things be trained. Tests recently carried out at one of the eastern frontier fortresses of France are illuminating in this respect. Two dirigibles charged with the mission of discovering the position of concealed batteries flew over the batteries at a height of 700 feet without ever seeing them.

The aeroplane will be probably used in conjunction with the airship in sieges. The aeroplane can approach the enemy nearer than the airship because its speed is higher, and because it is not so liable to be brought down by gun fire. The Austrian, Capt. Schimpflug, succeeded in taking serviceable photographs from a dirigible. From this it may well be inferred that photographs can easily be taken of an enemy's fortifications from an aeroplane.

It cannot be denied that such reconnoitering is difficult and extremely dangerous. The aerial pilot will be exposed not only to the massed fire of infantry and machine guns, as well as to the fire of bigh angle aerial field pieces firing shrapnel, but also to attack by the enemy's aircraft.

Thus, aerial scouts are much in the same position as naval scouts. If the flying machines are not driven off by the enemy's aircraft without having fulfilled their mission, they must be able to persist in their course despite aerial opposition. The speedier flying machine can avoid its opponent by darting off and fighting at its own range or by retreating. Battle of some kind must be waged. But how? Ramming is out of the question (for it means the total destruction of both flying machines). At Mourmolen, last March, the flying machines of Capt. Moreau and Frey collided. Both aeroplanes crashed to the ground. Although the height from which they fell was comparatively small, the machines were wrecked. Hence the two aeroplanes must disable each other by ordnance of some kind. Field pieces, even of the smallest caliber, would burden the flying machine far too much. Revolvers and pistols, as well as hand grenades, can hardly be seriously considered because their range is too small. To hit a moving object from a moving platform with a single fire arm is hopeless. Hence, the solution is necessarily to be found in the machine gun, which, because of its rapidity of fire and the stream-like character of its discharge, promises to have the desired effect. It is therefore necessary to devise some light machine gun which the aeroplane can carry without hampering its flight or its efficiency.

The throwing down of explosives is even less practical from an aeroplane than from an airship. A flying machine must hover above the ground not less than 1,500 feet because its unprotected parts are exposed to gun fire. The probability of hitting a target on the ground from that height, to be sure, is very slight. Furthermore, the size and quantity of the explosives carried for this purpose are necessarily limited. Much ammunition will make flying utterly impossible. Hence only small hand grenades, limited in quantity, can be carried along. At Los Angeles the experiment was made of throwing objects from aeroplanes at a target seven meters square. The French aviator Paulhan steered the machine, and the American Lieutenant Beck threw the projectiles. In spite of innumerable attempts, Beck succeeded in hitting the target just once. The conclusion must necessarily be drawn that if explosives are to be thrown from a flying machine, some form of projecting tube, provided with a directing device, is necessary. Much investigation will have to be done before the proper kind of projecting tube is devised.

It will be still another function of the flying machine to convey intelligence officers quickly from one point of command to another. If the wind conditions are not unfavorable, flying machines are to be preferred for this purpose to motor cars, since they are entirely independent of roads, and are able to fly as the bird flies, even over hostile troops, if necessary. Moreover, the mere fact that they traverse the air means that they will not add to the difficulties of army transport by clogging the roads.

For the conveying of hasty orders to the rear guard of an army corps and dispatching a command to bring up immediate reinforcements, the flying machine is admirably adapted, because of its great velocity, and also because it can oversee the entire country and immediately pick out the position of the reinforcements sought.

The following conditions must be fulfilled in a military flying machine:

1. It must be absolutely safe in flight, and its operative mechanism must be trustworthy. Hence, two motors will be required, so that in case one should fail, the other will serve to propel the flying machine. For the maintenance of equilibrium, some automatic pendulum arrangement or a gyroscope would seem necessary. Regnard is said to have succeeded in maintaining stability by means of a gyroscope measuring 10 centimeters in diameter and rotating at a speed of 10,000 R. P. M.

2. The flying machine must be perfectly controlled. In other words, it must be able to avoid hostile fire quickly by flying high or to one side. In this respect, the author of the article finds the modern flying machine not quite up to military requirements.

3. Flying machines must be able to carry at least two men, namely, a pilot and an observing officer. In addition to its human freight, it must carry a sufficient amount of fuel, as well as a machine gun and ammunition, and repair parts. Although the modern flying machine would hardly be able to fulfill these requirements as yet, it seems reasonable to expect that in the future its carrying capacity will be increased without too greatly diminishing its speed. Two men, moreover, have been carried time and time again for periods of over two hours.

4. The speed of the flying machine must be at least 25 to 40 miles an hour. This is easily attained, even at the present time.

5. The flying machine must be able to perform its military work, even though the velocity of the wind may be 40 feet a second. In Germany, at least, wind velocities of over 50 feet a second occur about five times a year. Hence, even this exceptional condition need be fulfilled but rarely. Still its fulfillment, with an aeroplane loaded as required, will be difficult.

6. The flying machine must be able to stay up at least 2½ hours in a moderate wind. Its radius must, therefore, be about 60 miles. This is now possible. The best record was made by Paulhan from London to Manchester, when he flew over 80 miles.

7. The flying machine must be able to travel at a height of 1,500 feet on an average, and occasionally to heights of 3,000 feet. A height of 1,500 feet will be absolutely necessary as a general rule in the vicinity of hostile troops. To avoid the high angle fire of special aerial artillery a height of 3,300 feet must be attained. This condition is easily met, even at the present time.

8. The flying machine must be able to start from any particular spot without the aid of special launching devices. It must also be able to begin a flight from an airship.

9. The flying machine must be able to land with absolute safety.

10. A seat must be provided for the observation officer, in such a manner that he can cast his eye to all sides, and yet so as to permit him to assume control of the aeroplane when necessary.

11. It must be possible to build such aeroplanes entirely of domestic material. In Germany at least, the difficulty of obtaining suitable motors is such that the best aeroplanes are equipped with French motors.

THE EFFECT OF ULTRA-VIOLET RAYS ON THE EYE.

AN inflammation, known as electric ophthalmia, is produced by even brief exposure of an unprotected eye to ultra-violet rays of very short wave-lengths. Fortunately these rays are absorbed by ordinary glass, so that the eye can easily be protected against them. The question has recently been asked whether the ultra-violet waves of greater wave-length, which are not absorbed by ordinary glass, and which are much more abundant in the radiations emitted by electric lamps and incandescent gas mantles than in the light furnished by old-fashioned gas burners and kerosene lamps, may not also injure the eyes. Dr. Schanz, of Dresden, attributes opacity of the crystalline lens and senile cataract to the agency of these rays. As sunlight and diffuse daylight, to which the human eye has completely adapted itself, and which may, therefore, be regarded as the normal illumination, likewise contain the longer ultra-violet waves, the important question is whether the eye receives such waves more abundantly from the modern powerful artificial sources of light, arranged in the usual way, than from daylight of equal illuminating power.

Dr. Voege, of Hamburg, has proved by numerous comparative tests that ultra-violet rays are far more abundant in daylight than in light of equal intensity furnished by incandescent electric and gas lamps and most electric arc lamps. An eye looking at an arc lamp receives fewer ultra-violet waves than it would receive from the rays of the sun reflected to it by a bit of polished metal at the same distance. Hence the modern powerful lamps are not injurious to the eye if certain precautions, which are required for the visible as well as for the ultra-violet rays, are observed. A powerful source of light should not be placed too near the eye, and an unnecessary intensity of illumination of the desk or work table should be avoided. The lamps should be so arranged and shaded that the dazzling incandescent source of light is not directly visible. The best method of illumination is the indirect system, in which the rays strike a white ceiling and are thence irregularly reflected to the table, producing an illumination very similar to that of diffused daylight. Unshaded incandescent gas lamps should be inclosed in opal or ground glass globes. For work with arc lamps and other lights of great photographic intensity spectacles made of glass which possess an especially great power of absorbing ultra-violet rays should be employed.

The hydrographer of the Admiralty reports that during last year as many as 497 rocks and shoals dangerous to navigation were reported, and 32 previously reported dangers were expunged from the charts. The surveying vessels charted a length of 932 miles of coast-line, and an area of 13,938 square miles was sounded over. The Indian Marine Survey charted 202 miles of coast-line, and sounded over an area of 4,985 square miles.

THE MECHANICS OF SAVING LIFE.—II.*

SAFETY PROVISIONS IN THE UNITED STATES STEEL CORPORATION.

BY DAVID S. BEYER, CHIEF SAFETY INSPECTOR, AMERICAN STEEL AND WIRE COMPANY.

Continued from Supplement No. 1810, Page 170.

ENGINE INSTALLATIONS.

THE power which turns the shafting and drives the machinery in our mills is furnished chiefly by large steam engines. These engines have fly-wheels weighing from twenty-five to seventy-five tons each, running at a rim speed of five or six thousand feet per minute. The energy stored in one of these wheels when operating is about equivalent to an average sized passenger locomotive, running at the rate of sixty miles an hour. If an engine is allowed to speed up, additional energy is imparted to the fly-wheel until it bursts from centrifugal force, unloosing a power which

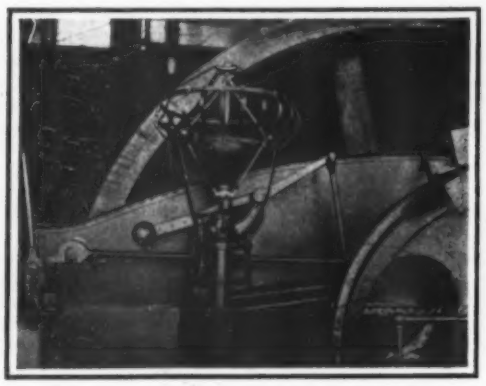


FIG. 10.—GUARD AROUND ENGINE GOVERNOR TO PREVENT ANYONE FROM BEING STRUCK BY THE "FLY-BALLS."

might be likened, roughly, to a locomotive and a train of several cars ploughing their way through the mill at the rate of "a-mile-a-minute." This terrific force is controlled and held in check by the "governor," which is usually an arrangement of two fly-balls revolving at a speed proportionate to that of the engine, and automatically reducing or increasing the steam supply. Certain parts of the governor may break and cause the engine to "race," and if the engineer cannot get a valve closed quickly enough the fly-wheel will "explode."

There is a safety attachment on the governor, which is intended to stop the engine in such emergencies, but engineers frequently allow this attachment to become ineffective. On a single inspection trip this was the case with ten out of sixteen engines observed. In one instance a roll of waste was placed under the governor bracket—in another a wood block was used—in others the bolts were clamped so as to produce the same result, in two or three cases the man in charge simply said he had "forgot" to fix it up after a shutdown. One grayhaired engineer of perhaps fifty years to whom I spoke about this condition, minimized the danger, saying, "I have been running this engine now for six years and have never had an accident," and yet on further questioning he admitted that such an accident might occur at any time, due to that insignificant handful of waste, and that probably he would be the first man injured. Each of the men running

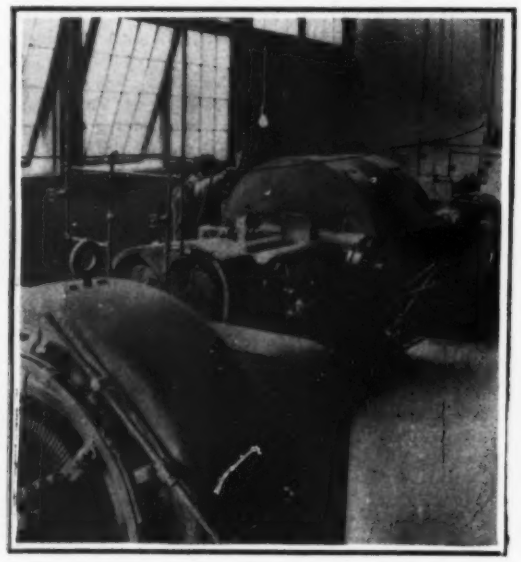


FIG. 11.—STOP ARRANGEMENT OVER ROLLING MACHINES.

By pulling the rope which operator is holding the switch is thrown out and motor driving machinery is instantly stopped.

these engines realized what might result from their interfering with the action of the governor, yet they all took the chance, because it never had happened in their experience.

To improve matters we are having counterweighted brackets placed under the engine governors, so that they will drop out automatically when the engine is running, without any attention from the engineer, and a written report is made weekly on one of the inspection blanks previously mentioned, which shows whether this safety feature is being used or not. As an additional safeguard, practically all the large engines in this company have been equipped with automatic stop valves having a speed limit attachment. These are intended to shut the engine down automatically when it exceeds a certain safe speed, and the valve may be closed also by pushing an electric button in various parts of the mill. At intervals here and there in the different departments there are little blue lights, each of which marks the location of a push button for the engine stop system. Sometimes they are on a column, sometimes suspended over a machine, and there are anywhere from five to six up to forty or fifty of them in each system. If a man is caught in the machinery, or there is a breakdown of any sort, one of these buttons is pushed, which shuts off the steam and stops the engine. Nearly one hundred of these stops have been installed in plants of the American Steel and Wire Company.

The push buttons operate by electricity—and the small wires which carry the current to the engine room may be broken, the push buttons may get out of order, or the batteries develop defects; here, if anywhere, "eternal vigilance" is the price of safety, and we have arranged that the daily shutting down of the engines shall be by means of these buttons, and that once a week each button shall be pushed with a man at the engine throttle to see that it works properly—the speed limit tried, the voltage of the batteries taken, and the lines tested for breaks; all of this being reported on a printed form. In several places butterfly valves have been placed in steam lines to engines—that is, a valve which closes instantly by pulling a lever; and chains or wire ropes are carried from this lever to convenient points for stopping the engine from a distance.

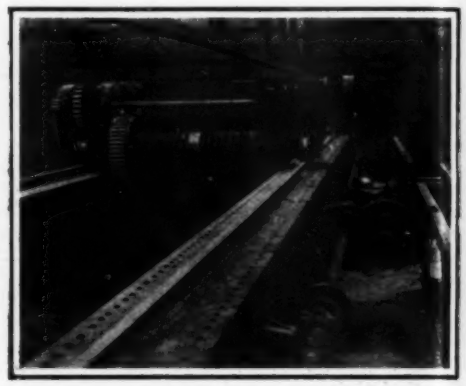


FIG. 12.—ELECTRIC TRAVELING CRANE BOUGHT ABOUT TEN YEARS AGO.

Shows open gearing, overhung gears, exposed couplings, etc. Foot walk on which men are standing was placed on crane after it had been installed.

MOTOR STOPS.

In departments driven by electricity, we have motor stops corresponding to the automatic engine stops described. In some cases these are arranged to operate by push buttons, and in others a rope is carried directly from the machinery to the switch controlling the motor, so that the switch can be pulled by means of the rope in case of emergency. Fig. 11 shows a series of machines having a stop of this sort. There is an operator at each set of rolls. Recently when one of them had his hand caught he cried out, and several of his fellow operators pulled the rope with such vigor that the switch was torn bodily from the board. The motor was stopped so quickly that only the tips of the injured man's fingers went into the

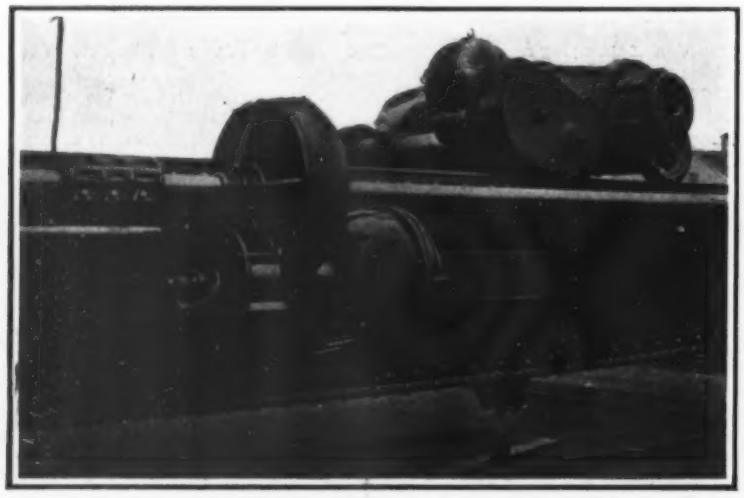


FIG. 13.—ANOTHER CRANE VIEW.

Showing what can be done in the way of protecting gears. It is practically impossible for any one to be caught in gearing of this crane or for any of the parts to work loose and drop.

FIG. 14.—WIRE DRAWER AT WORK.

The pipes suspended over the workman are connected with a central ventilating system.

* The Survey.

rolls, whereas his whole hand would undoubtedly have been crushed but for this safety stop.

ELECTRIC TRAVELING CRANES.

Electric cranes have been called the "giant laborers" of the mills. They pick up a ladle weighing twenty tons, with fifty tons more of molten iron inside it, carry, and pour it as readily as if it were a

FIG. 15.—IN A WIRE MILL.

Showing automatic stop levers through which wire passes.

FIG. 16.

A tangle at the reel throws lever forward, automatically shutting down the block affected. Lights on the columns mark push buttons by which the engine driving the entire department may be stopped.

cup of tea. Heavy rolls and housings used in the mills are lifted out and replaced by them, and in many departments all of the daily tonnage is handled one or more times by cranes. They are excellent servants, but sometimes they blunder, and a ladle of steel upset may mean disaster to a dozen men. There are gears and wheels which mangle—and twenty, thirty, forty feet of space underneath the man who falls from a crane bridge.

Some one has said that the education of a child should begin with its grandparents; certainly the best time to safeguard a crane is before it is bought. This method can be used when new machinery is being obtained, and in order to insure proper attention to these matters by crane builders, standard safety specifications have been prepared for use in ordering new equipment for the American Steel and Wire Company. These specifications provide for a foot-walk on the side of the crane bridge, with a toe-board along the edge of this walk; exposed gears are to be covered and overhung gears eliminated. (Examples of these conditions are shown in Figs. 12 and 13.) Limit switches are required to prevent a load being lifted too high and breaking away from the drum; a safety switch is to be placed on the upper part of the bridge so that a workman can throw out this switch and prevent anyone starting the crane from the cab while he is at work; safety couplings, brakes and bumpers are specified; also a gong which the operator can ring

FIG. 18.—PLANER IN MACHINE SHOP.

Showing cavity inside the bed covered by a steel plate to prevent workmen from reaching or falling into it and being caught by the traveling carriage.

to warn anyone underneath of the approach of the crane; a brush or prong is required which moves along the track in front of the crane wheel, and would push aside a hand or foot resting on the rail of the run-way before it would be crushed by the wheel. Wire ropes are also specified for hoisting purposes instead of the chains which have been used largely in the past; the failure of a single link in a chain means dropping the load, while several members of a wire rope may be broken without interfering with its service, and the broken strands give warning of weakness which would not be apparent in a chain.

One of the most important safety provisions for a crane is a foot-walk on the bridge (see Fig. 12) for the use of the crane operator, who must go all over his crane every day or two to oil and inspect it, and for the repairmen, who must handle tools and remove and replace parts of the crane. Where a foot-walk is not provided, it is necessary to walk on the upper edge of the girder, the surface of which is bisected by a rail, and broken up by rivets and bolts, and is, moreover, frequently slippery with grease or oil which drips from the bearings. If mention is made at the time the order is placed, any of the standard crane builders will furnish a foot-walk on the crane; but of course it adds slightly to the cost, and in view of the competitive bids on such work, it is only natural that the foot-walk should be omitted if it is not distinctly specified.

Where these general matters have not been considered in designing and arranging the different parts of a crane, it is difficult, and sometimes impossible, for an operating company to make all of the above safety provisions, but whenever practicable they are being installed on our old equipment.

FIG. 20.—VIEW IN NAIL MILL.

Showing safety hoods over emery grinders which are flanged out of solid piece of steel plate. The foot treadle must be held down while grinder is being used; as soon as treadle is released a spring throws overhead belt onto the "loose" pulley, stopping the grinder automatically. Walks for oilers will be noted in trusses at the top of picture.

FOR WIRE DRAWING EQUIPMENT.

Fig. 14 shows the arrangement of a modern wire mill. A coil of rods or wire is placed on a reel, from which it is drawn through a die to a revolving block, the opening in the die being smaller than the original wire, so as to decrease its diameter. It is possible by this process of cold drawing to reduce a quarter-inch rod to the thickness of a hair, that is, one or two thousandths of an inch.

There are several things which may occur to endanger the wire drawer; if the wire does not uncoil freely the reel may be dragged forward and crush him against the frame of the machine; a loop may spring over the top of the reel and catch his arm or foot, so

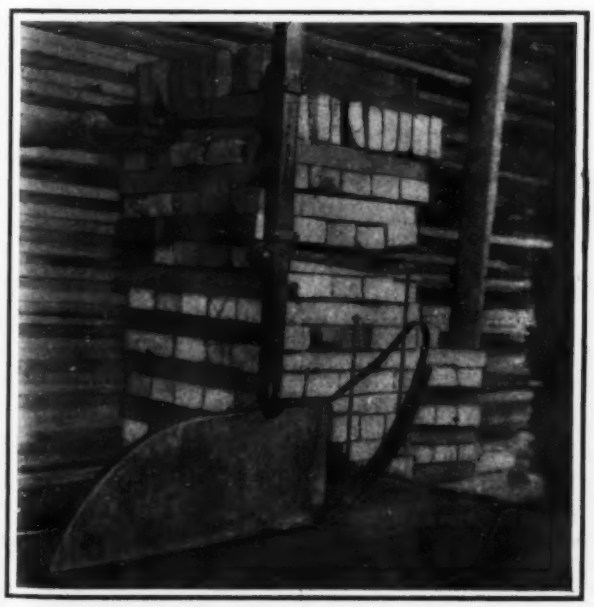


FIG. 17.—SAFETY HOOD OVER CIRCULAR SAW.

As a piece of wood is pushed under the front end of runner the hood raises automatically, resting on upper surface of the board, which slides underneath it.

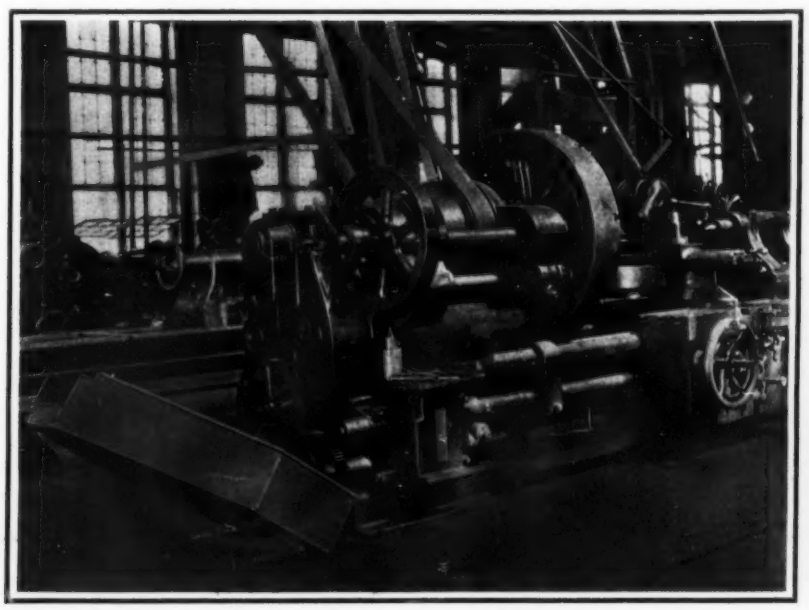


FIG. 19.—STEEL GUARD FOR END GEARS OF LATHES.

This can be readily swung out of the way for changing gears and it is a good expedient for protecting gearing of a machine which was not covered by maker.

that if the block is not stopped promptly the loop will tighten and lacerate, or even cut off the member; or the wire may break, and the flying end put out an eye, or cause a wound with blood poisoning.

In Fig. 15 is shown even more clearly the battery of levers sticking up from the floor. Each of these levers is arranged so that when it is thrown forward it automatically stops one of the drawing blocks. All that is necessary for the wire drawer to do is to place the wire through the eye (Fig. 16) in the upper end of the lever, and any tangle or flying loop will shut off the power without further effort on his part; or he can push the lever forward by hand and thus stop the block without going any nearer to it, thus eliminating the danger of being struck by the end of the wire.

In all of our wire mills some form of this stop has been put in. A number of different applications of it were assembled on one drawing and prints sent to each plant. It is simple and effective, the only objections to it being the amount of floor space it occupies and the second's time it takes to place the wire through the lever. It may save an arm, an eye, or even a life —and yet some of the workmen have broken them off, others have refused to use them, and after a campaign of several years along this line, one never goes into a mill without seeing some places where the operators carry the wire past the safety lever without using it.

MISCELLANEOUS SAFETY PROVISIONS.

In addition to the more common forms of protection, such as the elimination of projecting set-screws, covering of gears (Fig. 19), erecting of railings, etc., there are a great many provisions which could not be described in detail in an article of this sort. One of the dangerous occupations in the mill is that of oiling shafting and machinery. Wherever practicable arrangements have been made to do this while the equipment is not in operation; in some cases oil cans are used having light spouts ten or twelve feet long, which enable a man to oil overhead shafting without leaving the floor; in other cases railed walks have been erected along lines of shafting, so that the bearings may be reached without unnecessary risk or inconvenience.

Standard scaffolds with handrails are provided for the use of painters, riggers, etc., and a "painter's chair" has been designed which has a safety belt so that if a man were to fall out of the seat the belt would still hold him. Rules regarding the construction, inspection and testing of this equipment have been posted in all of the shops where such appliances are used.

Counterweights are being boxed so that they cannot fall on anyone in case a rope or chain breaks; covers and shields are provided for emery grinders (Fig. 20); safety stops of various kinds are arranged to enable machines to be shut down quickly in case anyone is caught; blacksmith's tools are inspected to see that the edges are not allowed to 'mush-room" until some one is struck with a flying chip; storage yards are inspected to see that material is not piled too close to the tracks; planer beds are covered in the machine shops (Fig. 18), and safety cylinders provided for all jointers in carpenter shops.

Accidents which occur are studied with a view of determining means for preventing similar accidents, and a constant effort is made to anticipate danger.

General specifications, rules, drawings and photographs of standard appliances are being compiled in a handbook, which is intended shall be to the safety inspector what the standard reference books are to the engineer; these handbooks will be furnished to those who are responsible for the design, installation and maintenance of equipment in our mills.

(To be continued.)

CORDITE.

THE CHEMISTRY AND MANUFACTURE OF A REMARKABLE EXPLOSIVE.

THE production of a smokeless powder was ever the dream of the military strategist, and with the discovery of gun-cotton the conclusion was hastily arrived at that the ideal propellant was found, only to be rudely dissipated by numerous serious disasters. Gun-cotton for many years resisted all attempts to render its combustion sufficiently under control for it to be adopted as a propellant, yet to-day it is the basis of the smokeless powders of all nations. Its early failures were entirely due to the retention in the nitrated cotton of the physical characters of the parent cotton, for even after reduction to an extremely fine state of division during the process of manufacture, the fibrous nature of the cotton persisted. Success has only been attained by the destruction of this fiber, and the smokeless powders of all nations may be classed either as simple gelatinized gun-cottons in which soluble nitrocelluloses have been gelatinized by treatment with an ether-alcohol mixture, or as nitrocellulose-nitroglycerine colloids, in which the nitrocellulose employed may be of the soluble variety, as in ballistite, or the insoluble (true gun-cotton), as in the case of cordite.

The introduction of blasting gelatin by Nobel (1875) consisting of some 90 per cent nitroglycerine with 10 per cent of soluble nitrated cotton in a gelatinized form, was the first step toward the production of powders of the cordite type. The high percentage of nitroglycerine rendered blasting gelatin unsuitable for use in guns, but by incorporating the two constituents in equal quantities, Nobel gave to the world the first successful smokeless powder of this class, ballistite. Cordite was the outcome of the work of a committee presided over by the late Sir Frederick Abel, and was patented a year later than ballistite, in 1889. The essential difference between ballistite and cordite is that while the former contains soluble nitrocelluloses, cordite contains the insoluble or tri-nitrocellulose. This change in the character of the nitrocellulose employed entailed the introduction of acetone in the manufacture of cordite. Soluble nitrocotton and nitroglycerine can be thoroughly incorporated under proper conditions in the presence of water without the aid of any solvent, but the ingredients of cordite can only become perfectly incorporated in the presence of a mutual solvent. It is essential that the solvent shall be sufficiently volatile to permit of its removal at reasonably low temperatures from the finished powder, and acetone, which boils at 56 deg. C. (132.8 deg. F.), fulfills all the conditions best.

It is important to note that nitroglycerine is the only explosive containing an excess of oxygen, all nitrocelluloses being theoretically deficient in this element to give complete combustion of carbon to carbon dioxide and hydrogen to water. There are therefore admirable theoretical grounds for the incorporation of these two explosives with each other. The total change in physical characters of both nitroglycerine and nitrocellulose brought about entirely alters the character of their explosion; singly, both constituents are beyond control once combustion is started; gelatinized together, combustion is regularly progressive throughout the mass, an essential condition for a propellant.

The earlier form of cordite consisted of nitroglycerine, 68 per cent; nitrocellulose, 37 per cent; vaseline, 5 per cent. It was soon found that serious erosion took place in the guns, and Sir Andrew Noble showed this to be due to the rapid motion of the gaseous products at very high temperature. Since the temperature is a function of the nitroglycerine content, combustion to carbon dioxide taking place to greater extent with its accompanying higher calorific intensity, it followed that reduction of the nitroglycerine would lower the temperature of the products and lessen the erosion. This led to the introduction of modified (M.D.) cordite of the following composition: Nitroglycerine, 30 per cent; nitrocellulose, 65 per cent; vaseline, 5 per cent—practically a reversal of the former proportions of the chief ingredients. The introduction of the vaseline was made to overcome metallic fouling in the gun, arising from surfaces of metal in practically a clean condition rubbing against each other as the projectile moved outward. The vaseline decomposition products provided just the slight lubrication needed. It has performed another important office, little thought of on its introduction, in acting as a "stabilizer" in the cordite.

In the manufacture of cordite, the gun-cotton employed is thoroughly dried at a temperature of 40 deg. C. (104 deg. F.), and is then mixed by hand with the proper proportion of nitroglycerine, the mixture being finally passed through a sieve. The "paste" obtained is transferred to an incorporating machine of an exactly similar type to that employed in a machine bakery, except that temperature control is arranged for, and there worked into a thorough dough with the requisite quantity of acetone. The first kneading occupies about three and a half hours; then the vaseline is added and a further kneading for a similar period takes place. "Cordite dough," in which every trace of the fibrous character of the gun-cotton has disappeared, results, and this dough is then shaped into the finished threads, cords, or rods by pressure through suitable dies. As the thinner makes pass from the press they are wound on drums, thicker qualities being cut into suitable lengths as they pass out on an endless band. The acetone remaining must now be removed by drying in suitable rooms at a temperature of 43.3 deg. C. (110 deg. F.) The removal of solvent from the larger sizes of all smokeless powders offers considerable difficulty owing to their horny nature; the odor of acetone is readily detected in freshly ground cordite after long storage.

Naturally the detection of products which may indicate decomposition actually occurring or likely to occur is important, and for this purpose Abel's heat test, first introduced for gun-gotton about 1875, is employed for cordite. The test depends on the liberation of iodine from potassium iodide by the action of nitrogen peroxide, the principal decomposition gas. The ground explosive is heated to 82 deg C. (180 deg. F.) in a tube, and the time noted for discoloration of the test paper to a certain standard tint. The question at once suggests itself, Does the test show decomposition products which were present in the explosive, or have they resulted from heating during the test, or both conditions acting together? Very divergent opinions are held as to the value of the Abel test as an indication of the stability or "life" of gelatinized explosives. Certainly a powder giving a bad test must be regarded with suspicion, but it is obviously not an easy matter to fix a time limit for a test which is subject to adverse criticism.

One of the most important considerations with any explosive is its stability. The question naturally arises, Is the molecular arrangement in such substances as nitrocellulose and nitroglycerine stable under ordinary conditions of temperature? Their explosive properties depend entirely on molecular rearrangement, which is practically instantaneous when detonation occurs. Certainly slow decomposition occurs in most nitro-compounds of the explosive class at temperatures not greatly above the normal with the production of oxides of nitrogen, and it has been shown that these oxides act catalytically on the explosive; in other words, their effect becomes cumulative and may lead to ignition. In order to avoid this catalytic action, "stabilizers" have been introduced in many explosives, substances capable of absorbing these nitrogen compounds. As already mentioned, the vaseline in cordite appears to perform this useful function.—Nature.

In a paper entitled "The Influence of Pressure on the Boiling-Points of Metals," published in the Proceedings of the Royal Society, H. C. Greenwood describes the methods of determining the boiling-points of metals at pressures below and above atmospheric, and the experimental results obtained. For pressures below 760 millimeters the heating arrangement used was similar to that used for boiling-point determinations at atmospheric pressure. A side tube was arranged down which temperature readings were taken with a Wanner optical pyrometer, and this tube was kept clear from fumes by a slow current of nitrogen or hydrogen. The principal results of the investigation are given in the following table, each value being the mean of several concordant experiments:

Metal.	Pressure in millimeters.	Boiling-point.
Bismuth	102	1,200 deg.
"	257	1,310 "
Copper	100	1,980 "
"	257	2,180 "
Lead	105	1,320 "
"	266	1,420 "
Silver	103	1,660 "
"	263	1,780 "
Tin	101	1,970 "
"	262	2,100 "

To study the effects of high positive pressures on the boiling-points a much more elaborate apparatus was necessary, and various troubles arose; the observations of the metal surface were less definite than those obtained at lower pressures, and sublimation below the boiling-point seemed to be more pronounced. The following results were obtained:

Metal.	Pressure in atmos.	Boiling-point.
Lead	1	1,525 deg.
"	6.3	1,870 "
"	11.7	2,100 "
Bismuth	1	1,420 "
"	6.3	1,740 "
"	11.7	1,950 "
"	16.5	2,060 "
Zinc	6.3	1,120 "
"	11.7	1,230 "
"	21.5	1,280 "
"	53	1,510 "

SYMBIOSIS.

A SIMPLE EXPLANATION.

BY ADOLF MAYER.

THE association between two living organisms of different species which is called symbiosis is analogous to a partnership between two men, of whom one directs the commercial and the other the technical part of an industrial enterprise. There is a strict division of labor. Each partner is necessary to the success of the venture and each does the work for which he is best fitted by natural aptitude, training and experience.

Symbiosis may also be likened to a blind man carrying a cripple on his shoulders. The cripple points out the way which his bearer blindly follows and thus both reach the goal which neither could have attained alone. But this striking image, like most images, is false. The cripple and the blind man are defective and abnormal, but true symbiosis is the association of two organisms whose limitations have been brought about normally in the development of their respective species and are, in general, beneficial. For a true picture of symbiosis we must select an actual case of symbiosis, like the classical example of the part played by bees in the fertilization of flower seeds. The plant is rooted in the ground and is consequently unable to effect the cross-breeding which is required for the production of healthy offspring. In other respects this permanent and intimate connection with the soil is advantageous to the plant, which is thus freed from the necessity of seeking its food and is nourished without effort, like a stall-fed ox. The plant is able to fertilize its own seeds, but the vigor of its descendants gradually diminishes if self-fertilization is practiced for several generations. Now the development of the bee has followed a direction exactly opposite to the path taken by the development of the plant. The insect has acquired great mobility and for that reason it requires a large quantity of food, which it is compelled to seek. It finds its food in the pollen and nectar, which are produced in profusion by the well-nourished plant, and in obtaining this food it incidentally conveys pollen from one plant to another. Thus both partners are benefited: the bee by an abundant supply of food, the plant by the production of a vigorous progeny.

Another classical example, which we owe to Schwendener, the Nestor of German botanists, is the symbiotic association of algæ and fungi to form lichens, which were formerly regarded as distinct species of plants. The alga and the fungus can live separately, but they have been developed in opposite directions. The alga produces organic matter in abundance, but exerts only a feeble solvent action on the soil as it commonly lives in swamps, where the mineral food which it requires is already in solution. The fungus, on the contrary, exudes acid secretions which attack the soil, from which it extracts the organic substances which it is not able to produce itself. In presence of decaying organic matter the fungus grows luxuriantly without assistance.

Now suppose that the alga and the fungus are thrown together on the bark of a tree, which contains little soluble organic matter, or on a rock, which contains none, although both rock and bark contain mineral food in abundance. The two plants form an association for mutual benefit. The alga shares with the fungus the organic substance which it produces from the carbon dioxide of the atmosphere, and the fungus attacks the rock with its acid secretion and extracts mineral supplies for the common household. The association is very beneficial to both partners and the firm persists through many generations. The two plants are so intimately associated that lichen formed by their combination was long regarded as a distinct and single organism.

Another interesting example of symbiosis is given by the association of the medusa with the fish *Curanx auratus*, which seeks protection from its enemies amid the stinging appendages of the medusa. The zoologist Semon observed that the fish, more intelligent than its associate, repays this service by discovering the lurking foes of the medusa and hurrying its gelatinous host away from the place of danger. The association between fish fry and the spiny sea-urchens appears to be of similar character.

For the farmer the most important example of symbiosis is the association of leguminous plants (peas, beans, clover, etc.) with nitrogen-assimilating root bacteria. The leguminous plant is capable of independent existence, but when growing in poor soil it derives great benefit from the nitrogen-assimilating property of the bacteria, which, in turn, obtain from the higher plant the sugar and other carbohydrates which they require and are unable to produce. In this case, as in the lichen, the carbohydrates are supplied by the higher, chlorophyll-bearing plant, but the albuminoids furnished by the bacteria are far more important and less easily obtained than the mineral substances which the fungus contributes. This fact explains the immense practical value of the root bacteria. The discovery of their functions has brought about a revolution in agriculture and has immortalized the name of the discoverer, Hermann Hellriegel.

The *Mycorrhizæ* which infest the roots of forest trees, like the fungi associated with algæ in lichens, exert a strong solvent action upon the soil and thus supply the trees with mineral food. Many other examples of symbiosis might be cited. Symbiosis is probably as old as life itself, for pre-Devonian fossil corals are found associated with worms of the germs *Serpula*, and living corals form similar associations.

When regarded from a purely technical or mechanical point of view, parasitism appears akin to symbiosis, for in parasitism also two dissimilar organisms live together. Economically, however, parasitism is the very opposite of symbiosis, for in parasitism there is no fair exchange of benefits but only robbery, the parasite alone deriving any advantage from the union and living at the expense of its associate, which is appropriately called its host. The mistletoe injures and sometimes kills the tree on which it grows. Intestinal worms, vermin and parasites in general injure their hosts. There are, however, transitional and doubtful cases. Intestinal bacteria, for example, do harm by converting carbohydrates into methane and carbon dioxide, thus robbing their nost of his food and causing flatulence, but they also assist in the synthesis of albumen from amides and ammonia. Even the blood-sucking leech is useful in the cure of disease.

The name commensalism (i. e., feeding together) has been given to an association intermediate between symbiosis and parasitism, from which each member derives individual advantage without either benefiting or injurying its associate.

A similar uncertainty of definition and delimitation exists in human society, where it is often doubtful whether a given social phenomenon is a case of parasitism or of economically sound division of labor, the decision is made more difficult by partisan prejudice. Socialists denounce capitalists, and even contractors and organizers, as parasites on the social body, but they forget that capitalists do important work, even in the usual sense of the word. In certain stages of social development, however, the man of wealth may sink to the level of a veritable parasite by failing to comprehend his mission, which is to lighten the labor of society in general by means of an organization which he alone is able to effect.

Even the suckling of infants and other young mammals may be regarded as an example of parasitism. In the purely economical sense, the process is certainly parasitic, and it is tolerated in the rearing of domestic animals only because the growth of the young animal is often more valuable than the milk of the mother. If this is not the case, the young animal is fed on a substitute for milk or is killed, like a true parasite. But these are artificial conditions. Biologically, as well as from a human viewpoint, the definition of suckling as parasitism appears very crude and incomplete. The human mother feels infinitely overpaid for her milk by the sight of her thriving babe. As this feeling is instinctive it must be shared by non-human mothers, and observation shows that this is true. In the higher sense, therefore, suckling is not parasitism, but is a variety of symbiosis in which a material is exchanged for a psychical benefit.

In some cases of symbiosis one of the members has become so dependent upon the other, as a result of development and selection operating through many generations of symbiotic association, that it is no longer capable of maintaining an independent existence. Some of the slave-holding ants have become so accustomed to the services rendered by their slaves (which they repay by other services made possible by their higher intelligence or peculiar instinct) that they starve to death when they are deprived of their slaves. Some plants have become so accustomed to having their roots and stems inhabited by ants and termites that they form cavities without assistance from the insects and even without any stimulus exerted by them.

Two originally unrelated species may even become so closely amalgamated by long continued symbiosis that separation is impossible. This thought, followed to its logical conclusion, leads to the conception of a higher organism as a community of living cells and the conception of a cell as an individual organism. This view receives apparent support from certain observed facts, especially from the independent activity of the white blood corpuscles, which destroy intruding bacteria, assist in the regeneration of albuminoids from peptones, promote the healing of wounds, and in all respects closely resemble those really independent unicellular organisms which are known as amœbæ.

Such ideas are seductive, but dangerous, because they may lead to fantastic theories. To the writer the conception of one's own body as a fortuitous assemblage of animalcules appears as uncanny as the dying Heine's grewsome picture of his thoughts as ghosts revelling in a brain already dead. Fortunately we are not compelled to form such horrible images as these, but it would be well worth while to endeavor to determine by experimental investigation whether certain groups of cells in higher organisms may not be naturalized foreigners, like the intestinal bacteria, which, though their importance is often exaggerated, appear to be now necessary for complete digestion.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

NATURE'S VARNISHES.

THE lacquers of China and Japan are prepared from the natural varnishes yielded by different species of Rhus, while the Indian marking nut, *Semecarpus anacardium*, contains a yellowish fluid which produces so permanent a stain on linen or paper that it is employed as a marking ink.

Another member of the family, *Anacardium occidentale*, produces the fruit commonly known as the Cashew nut, which also contains a juice that gives a dark brown stain on exposure to air, but, unlike the juice of the Indian marking nut, does not become black. Experiments made by the present writer have shown that the brown oil in this nut dissolves in potassium hydroxide solution, and combines with lead to form a red salt. This is probably a compound of the reddish yellow oil separated by Staedeler in 1847 and termed *anacardic acid*.

Like all these natural varnishes, or inks, the Cashew nut contains an active principle which produces an irritation of the skin, and the fumes obtained on roasting have a still more pronounced effect, which in the case of the cashew nut, is attributed to an active principle termed *cardol* ($C_{21}H_{30}O_2$). In the case of the *poison ivy* (*Rhus toxicodendion*) of North America, which is closely allied to the plants producing the Chinese and Japanese lacquers, the juice of the leaves will raise a blister on the skin within forty-eight hours, and even the vapors emitted by the plant, especially at night, may produce eruptions on the skins of peculiarly sensitive people.

One of the most interesting of these natural vegetable varnishes is that derived from *Coriaria thymifolia* and *C. myrtifolia*. The former is known in New Granada as *chauci* or the "ink-plant," owing to the fact that its red juice rapidly becomes black after exposure, and gives so permanent a stain upon paper that it can be used as an ink without special preparation. According to Johnson (*Universal Cyclopædia*, New York, 1894) all the early documents in Spanish South America were written with the juice of this plant. It also grows in New Zealand, where, too, it is known as the "ink-plant."

The oxidation of the juices of plants of the Rhus family has been shown to be brought about by a special enzyme or *oxidase*, and it is extremely probable that a similar agency accelerates the combination of the atmospheric oxygen with special compounds in the juices of the other varnish-producing plants. This, however, has yet to be proved.—Knowledge and Scientific News.

Galazym, a variety of fermented milk, often used in Asia as a substitute for kefir or kumiss, is prepared according to the following directions: Four parts of beer yeast are dissolved with 10 parts of sugar in water and added to 1,000 parts of fresh cow's milk. This causes the milk to ferment, and it is kept in well-closed bottles in a cool place. The finished beverage contains 1 to 2 per cent of alcohol.

PHOTOGRAPHY IN NATURAL COLORS.

THE DUFAY PROCESS OF COLOR PHOTOGRAPHY.

BY G. MARESCHAL.

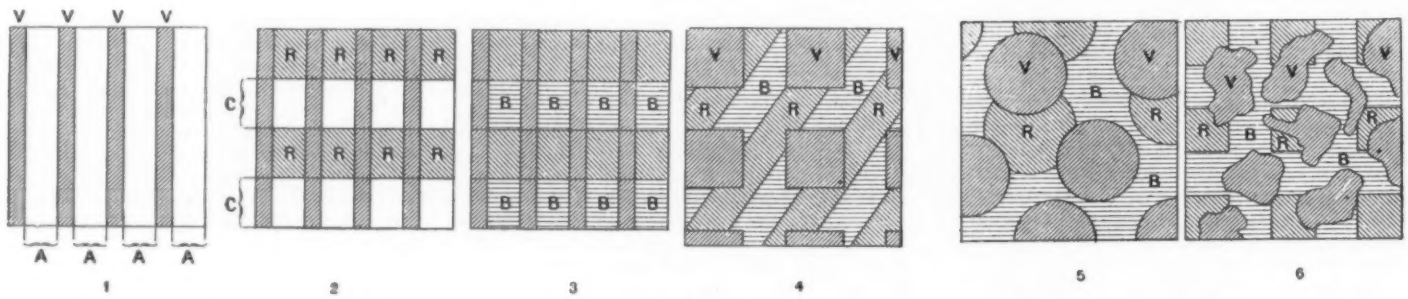
THE principle upon which the indirect solution of the problem of photography in natural colors is based is so well known that no detailed explanation is required. Let us recall merely the fact that a series of very small transparent areas, colored respectively green, orange-red, and violet-blue, are arranged side by side upon the glass plate to which the sensitive emulsion is to be applied. These small colored areas act as ray filters during the exposure, and also constitute, after development, the elements which give color to the picture. For this purpose M. Lumière employed colored starch grains, and M. Jougla used a screen formed of two series of lines at right angles to each other.

Now, Dufay, with the assistance of the Guilleminot establishment, has produced what he calls a "dioptichrome" plate by the ingenious method of impressing upon the glass a series of partial protective coatings and staining the unprotected portions. In this method the colored areas may have any desired form and arrangement, but the grating formed of two systems of mutually perpendicular lines has been adopted for the present.

The manufacture of these plates can be followed readily by means of the accompanying illustrations. In the first place, the glass is covered with a transparent coating of gelatine or collodion, which contains no emulsion sensitive to light, but is capable of taking a stain. In the second place, a series of parallel bands *A* (Fig. 1) is printed on the plate with a fatty mixture. The intermediate bands *B* are approximately half as wide as the bands *A*. If the plate thus prepared is immersed in a green dye only the bands *V*, comprising about one-third of the surface of the plate, take the color. The plate is then covered with a varnish which does not dissolve fatty matter. By means of a suitable solvent which does not attack the varnish, the fatty matter which covers the bands *A* is then dissolved off, carrying with it the varnish which covered it, so that the varnish now covers only the green bands *V*, which it protects against any other stain. A new system of bands *C*, at right angles to the first system, is now printed in fatty matter on the plate. The width of these bands is approximately equal to that of the intervals between them, so that they leave uncovered about one-half of the still undyed surface, or one-third of the entire surface of the plate, i. e., the squares *R* (Fig. 2). The plate is next immersed in an orange-red dye, which is absorbed only by the squares *R*, as the rest of the surface is protected either by fatty matter or by varnish. The twice-dyed plate is again covered entirely with varnish. The green bands have now received two coats of varnish, but as the varnish is perfectly transparent and colorless, it does not affect their tint. Another immersion in the fat solvent removes the fatty matter and the varnish over it from the squares *B* (Fig. 3) which occupy the remaining third of the surface, and which are then stained by immersion in a violet-blue dye. All of these operations are performed in full daylight. The color screen is now complete. All that remains to be done is to coat it with sensitive emulsion in the ordinary manner.

This method of "reserves" employed by Dufay presents several advantages. It makes it possible to employ four or five colors, if necessary, and to give to the color screen any pattern desired. Figs. 4, 5, and 6 show a few of the patterns with which the inventor has experimented. The examination of these figures shows that it is quite difficult in these conditions to balance the colors exactly, as the colors are scattered in a haphazard fashion without mathematical regularity. Nevertheless, it is possible that these methods, which are still in the experimental stage, may give excellent results in certain cases. At present the rectangular grating (Fig. 3) is used in commercial plates. These plates contain 192 colored points per square millimeter (124,000 points per square inch).

I shall not give a detailed description of the treatment of the dioptichrome plates, which does not differ essentially from that of other plates used in color photography. During the exposure a screen of yellow glass should be placed in the path of the rays, either before or behind the lens. The plate is placed in the plate holder with the glass side toward the lens, so that the light traverses the colored areas before it reaches the sensitive emulsion. The yellow screen is of very pale tint, and the colors used in the formation of the plate are very transparent. These conditions shorten the exposure and facilitate lantern projection. A hydroquinone and metol developer is recommended. The developed image is reversed by means of an acid bath of potassium bichromate, and the plate is then redeveloped with hydroquinone and metol. A few minutes washing completes the operation. If the time of exposure has been correctly estimated the development is complete in three minutes. Its progress can be watched by means of a green lantern, but the examination must be made rapidly, especially in the first stage of development. If necessary, the negative can be intensified or reduced by the processes commonly employed in ordinary photography.—La Nature.



FORMATION OF STAINED PLATES FOR DUFAY'S COLOR PHOTOGRAPHS.

THE EFFECTS OF FIRE ON BUILDING MATERIAL.

IN a paper read before the American Society of Mechanical Engineers, Mr. F. B. Gilbreth, in discussing the effects of fire on building material, remarked that in this age of conservation it was amazing that so little had been done to prevent destruction by fire, and to apply the lessons which were taught by every great fire. All great fires were alike; building material behaved the same in the case of fire, whatever the location. The building of the Mutual Life Insurance Company at San Francisco was a steel frame structure, eight stories high, of the best construction in 1892, when it was erected. The laying up and filling of the joints in the brick, stone, and terra cotta were as nearly perfect as possible. The exterior wall completely incloses the steel frame, which was put together with bolted connections. The floors were of hollow terra cotta flat arches, and the partitions were hollow terra cotta blocks. The damage to the building, which necessitated the removal of the six upper stories, was practically all done by fire. This building was excellent for an illustration, because it showed the good and bad points of many different kinds of incombustible materials which were used in its construction. The lessons from this and from all fires pointed to the conclusions that no structure of the future should either be built of wood or should contain any wood. A very small quantity of wood in a so-called "fireproof" building almost entirely of non-combustible materials would furnish sufficient heat to destroy it.

Concrete construction was the best form for the elimination of fires, because the amount of damage done by fire in a concrete building depended upon circumstances which were within control and were predeterminable. With concrete made of properly selected fire-resisting materials practically no damage was done, except by prolonged high temperature. The results of recent tests by I. H. Woolson and J. S.. Macgregor proved conclusively that a properly designed concrete building, with as few projecting corners as possible, would withstand long periods of the hottest hardwood fires, with no resulting damage that could not be repaired with mortar.

These tests were carried out on full-sized rooms with walls of concrete made of different kinds of material. Concrete for walls could be poured in metal molds with sufficient accuracy to permit of painting or wall-papering without further plastering or smoothing, which meant that the best of this fire-resisting material was brought to the surface of the wall where the flames would strike. If a fire did occur in a building made of concrete cast in smooth metal forms, the damage was less than in any other type of building and the danger of spreading was less. Water did not injure concrete; in fact, it improved its quality. There was no wood to swell and afterward to shrink and crack the plastering, and no hollow spaces that the water could flow through, damaging the contents below. A concrete building was watertight from floor to ceiling, and small quantities of water could be easily handled through small scuppers, either into the air space of the vaulted wall or through the wall to the outside. The fire was never hidden by the construction; consequently no unnecessary streams of water were flooded into the building.

In a concrete residence there were few parts that could not be made better and cheaper of Portland cement than of wood. There were many first-class noncombustible materials besides Portland cement that would fill every good requirement of wood and still be fireproof. The spread of a fire into adjoining parts of the same story was possible in a concrete building only through doorways, pipe holes, etc., and a concrete wall was an ideal barrier to the spread of any fire. The work to be done to reduce fire losses to a minimum was so great and so important that it could never be accomplished until the government took it in hand. The government could aid fireproof construction by passing laws restricting the use of wood in buildings, by levying taxes, discriminating in favor of fireproof houses and against wood in construction; by teaching the people how to build fireproof houses; by establishing a government bureau for disseminating information regarding honest and unbiased fire tests on material, together with government experiments on different full-size buildings—kinds, types, materials, etc.—with bulletins of the progress; and by building fireproof houses for the use of government departments, and disseminating information concerning them by means of bulletins.

According to D. W. Shea in the Physical Review, the highest temperature in a divided Bunsen flame is confined sharply to a small zonal segment of the inner conical shell, no matter what substances are used to color the flame, nor what the distance is between the bases of the cones, provided that that distance is at least a few centimeters. The temperature of the inner conical shell is not changed by varying its distance from the outer conical shell, provided that the distance is more than 2 or 3 centimeters, nor by introducing through it metal vapors that burn in a flame above it and in the outer cone. The temperature distribution of the inner conical shell changes to one that increases from base to apex when the distance between the cones approaches zero. The temperature of the flames of metal vapor burning just above the inner cone is the same for all the vapors used, except near the tips of these flames, and it is not changed by varying the distance between the cones. The temperature of the outer conical shell increases from the base to the apex, and it is always greatest at the apex. The temperature of the other conical shell increases when its distance from the inner cone decreases; also when it burns metal vapors introduced through the inner cone. For any given divided Lunsen flame, the parts having the higher temperatures show the larger electrical wanderings, whether the flame be simple or one colored by any one of the elements studied.

ATMOSPHERIC ELECTRICITY.*

A REVIEW OF RECENT RESEARCHES.

BY CHARLES E. BENHAM.

THE atmosphere is almost always electrified, generally with positive electricity, the potential increasing with the height above the earth. Occasionally, especially during and just before a heavy rainstorm, the air is negatively electrified, and sometimes it changes its sign with great frequency, becoming alternately positive and negative every few minutes, or even every few seconds. But air being a non-conductor, its charge is not readily given up, and, therefore, an electroscope held out at an open window will not be charged, although the instrument is entirely surrounded by the electrified air. Even if the electroscope is fitted with a pointed terminal it will not take up a charge from the air under ordinary conditions, because the density of the atmospheric electricity is so slight that the sharpest needle will not assist its discharge, as would be the case with a denser electrification. To get a point sharp enough to conduct it away from the air a flame must be used. If to the terminal of the electroscope is attached a piece of cotton-wool soaked in

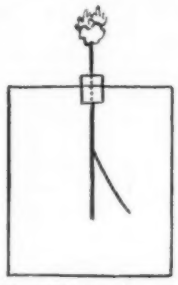


Fig. 1.—Electroscope, with burning methylated spirit on terminal, to collect electricity outside upper window.

methylated spirit and ignited, the gold leaves will readily expand when the instrument is held out only a few feet from an upper window (Fig. 1).

A piece of lighted touch-paper will make an equally effective conductor. More conveniently still, if the touch-paper is fixed to an insulated metal ball at the end of a pole projected from the window, and a wire is led from the ball to the electroscope indoors, there will be a divergence of the gold leaves (Fig. 2). It was in this way that atmospheric electricity was collected more than a hundred years ago.

Or the charge may be obtained by induction. If the insulated ball, without the touch-paper, is held out at the window, it will be under the inductive influence of the electrified air around it, like the plate of an electrophorus on its resin cake. To charge the electrophorus plate it has to be earthed while under the influence of the resin; and in the same way, if the insulated ball at the end of the pole is touched with an earthing-rod, it receives a charge by induction from

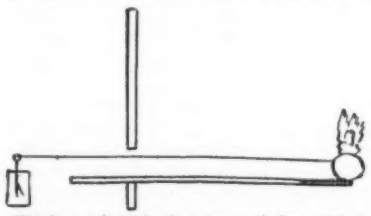


Fig. 2.—Wooden rod projecting from window with insulated metal ball at the end. The flame of lighted spirit rises from the ball and collects atmospheric electricity, which is conveyed by a wire to an electroscope inside the house.

the electrified air around it. The charge in this case will be of opposite sign to that of the air, and when the ball is brought indoors and applied to the electroscope it will show signs of electrification. It will show no such signs through a wire while still held outside, because its electricity is held bound by that of the air, just as in the case of the electrophorus plate until it is removed from the resin cake. The inductive method of obtaining an electrical charge from the air is, therefore, rather a tedious operation, and some better plan is desirable. Falling rain is generally electrified, and in this case the electricity is very easily collected by direct conduction. An insulated metal plate at the end of a rod is all that is necessary to receive the charge from each falling drop, and a wire leading from the plate to an electroscope indoors will convey the electricity to the instrument, and make the gold leaves diverge; but when it is not raining the problem is not so simple.

Returning to the inductive method of collection a great increase in the quantity collected per square inch of the collector can be effected by substituting for the metal ball an insulated flag mounted on an ebonite rod at the end of a pole (Fig. 3). If the flag is touched with an earthing-rod it receives a charge by induction, just as the ball would. If now before bringing it

FIG. 3.—Insulated flag at end of a pole. When projected from an upper window the flag, if touched with a rod, becomes charged by induction with electricity of opposite sign to that of the air. The earthing-rod being removed, the flag is rolled up and then brought into the room, when it will exhibit strong signs of electrification if brought near an electroscope.

indoors the flag is carefully rolled up, by revolving the pole, all the electricity that was spread over its surface is necessarily condensed upon the much smaller area of its rolled-up state, and the density is consequently increased in proportion, so that when the rolled-up flag is brought carefully into the room it will cause the gold leaf electroscope to diverge to its widest limit even when the air is but slightly electrified, and there will generally be enough electricity to ring a small electric chiming bell (Fig. 4).

The method of obtaining electricity by means of lighted touch-paper at the end of a rod has the disadvantage of requiring a renewal of the lighted touch-paper for each experiment. Lord Kelvin's water-dropping apparatus does away with this objection. In Kelvin's water-dropper an insulated water-can stands inside the room on the window-sill, and has a long spout, pointed at the end, projecting about three feet into the air (Fig. 5). Each drop from the dripping

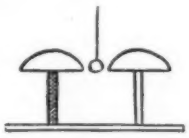


Fig. 4.—Two gongs of metal, one insulated, between which hangs by a hair a small brass bead or ball. On applying the charged flag (Fig. 3) to the insulated gong, the ball is attracted and repelled alternately, striking the gongs.

spout carries with it an induced charge from the air, and, therefore, one of opposite sign to that of the air. This leaves the can with so much less of that opposite electricity, and in this way it becomes charged in a short time with electricity of the same potential as that of the air and of a similar sign. The dropping necessary to effect this may be so slight that it can be continued for a long while before emptying the can, and the experiment has, therefore, great practical advantage over the flame or lighted tinder.

But the recent discovery of the ionizing powers of radioactive substances has opened the way to a more permanent method of observing the effects of atmospheric electricity, and one that when once established practically needs no further attention. This system is due to the ingenuity of Mr. F. H. Glew, of Clapham Road, who has secured the patent for an atmospheric electricity collector based upon the ionizing properties of radioactives, which by that agency render the air around them conductive. Mr. Glew's collector consists

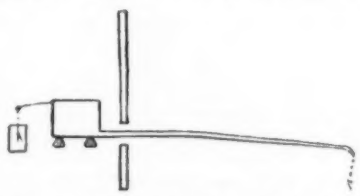


Fig. 5.—Lord Kelvin's water-dropper. An insulated water-can has a long spout, which is projected at bottom of window. The water that drops from the spout carries away an induced charge of opposite sign to the electricity of the air, and the can consequently becomes charged with electricity of same sign as the air. Electroscope is attached to the can.

of an elevated rod, or pole, to the extremity of which is attached an insulator bearing a terminal coated with a radium salt. This has the property of rendering the air in its immediate vicinity a conductor of electricity, and so an insulated wire leading from it into the house may be connected with an electroscope, and give continuous indications of the electrical conditions outside. Powdered pitchblende spread over a surface of not less than about six inches square will answer practically as well as radium (Fig. 6).

An important point in a permanent installation is the careful insulation of all supports, and for this purpose nothing is so good as sulphur. A sulphur rod would, however, be too brittle to support the metal plate bearing the pitchblende when exposed to the force of the wind. The plate must, therefore, be mounted on a stout rod of ebonite or varnished glass, to the outside of which a thick coating of sulphur has been applied. A tin cover of cylindrical form protects the rod from the rain. The wire from the collector is brought into the house through a sulphur insulating plug fitting into a hole cut through the window-frame.

The electroscope used may be of the ordinary form;

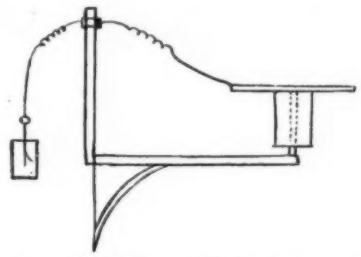


Fig. 6.—Mr. F. H. Glew's atmospheric electricity apparatus, but with plate covered with pitchblende in place of radium. The plate is mounted on an insulating-rod protected from rain by a surrounding canister. The collector stands a few feet out from the wall on a rod supported by a bracket. A wire from the plate leads through a sulphur plug in the window-sash, and is connected with an electroscope in the room.

but aluminium foil will be found preferable to gold leaf, which is very troublesome to manipulate. If a metal gong is fixed to the terminal of the electroscope it will serve the double purpose of protecting the sulphur insulator from dust and of acting as a chiming bell. A small metal ball is supported by a hair so that it hangs all but touching the gong, and also nearly in contact with a metal strip on the other side of its diameter, so that it is free to swing between the two, chiming every time it strikes the gong (Fig. 7). As soon as the potential of the air rises to a point at which the electroscope leaf expands to about 45 deg., the electricity will be sufficient to attract the ball to the charged gong. When charged it will be repelled, and

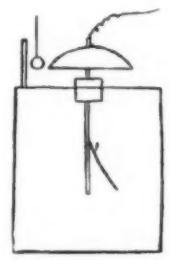


Fig. 7.—Combined electroscope and chiming-bell, the gong forming a cover to the sulphur insulator of the instrument, and being struck by a small brass ball suspended by a hair between the gong and a strip of metal.

will strike the metal strip, giving up its charge and swinging back to the bell. This it will do continuously until it has discharged the electroscope, though the supply from the atmosphere will probably be enough to replenish the amount taken away by the ball. If the ball is made as light as is possible consistent with its being able to produce a note from the bell, there will be few days on which there is not sufficient electricity in the air to set the bell ringing, and during a storm or squall the ball will oscillate with considerable violence and rapidity.

The interest of the instrument is enhanced by adjusting a low-power microscope so that the foil is within its focus. It will then be observed that the leaf is generally in a state of tremulation with the momentary variations of potential of the atmospheric electricity. These tremulations become very vigorous during rainstorms and thunderstorms, when no microscope is needed to observe the frequent changes of potential.

* English Mechanic and World of Science.

The sign of the electricity may be ascertained by bringing a rubbed piece of celluloid near the electroscope. If the leaf falls, as it usually does when the celluloid approaches, it shows that the electricity of the air is at that time positive. When the air is negatively electrified, which is a sure sign of impending rain, the leaf expands further on the approach of the celluloid.

To make the collector record automatically the electric conditions, a somewhat more elaborate arrangement is necessary. The aluminium leaf must be replaced by a light reflector which directs the beam of a lamp on to a revolving cylinder covered with photo-sensitive paper, and revolving once in twelve or twenty-four hours. The beam of light will thus trace a record of the displacements of the reflector by electric repulsion, and a permanent record of the day's electrical conditions will be made.

WIRELESS TELEGRAPHY AND TELEPHONY.

A REVIEW OF RECENT PROGRESS.

BY H. MARCHAND.

IN a former article (translated in SCIENTIFIC AMERICAN SUPPLEMENT No. 1770, December 4th, 1909) an account was given of the progress made in wireless telegraphy and telephony in 1907 and 1908. The improvements introduced in 1909 have followed the same tendency toward a more general adoption of sustained or feebly damped oscillations.

1. *Generation of Waves.*—The method of mechanical generation has not been extended in practice, although patents have been obtained by the American General Electric Company for alternators of high frequency, and the question has been discussed by the American Association of Electrical Engineers. Marconi has installed his disk spark-producer at the Poldhu station. Balsillie has formed a company for the exploitation of a spark-producer which consists essentially of a cylinder bearing long curved teeth and revolving between two rows of fixed teeth. The cylinder is six inches in length and produces thirty sparks on each side. The interval between discharges is very small, but the rotation produces great pressure and resistance between the fixed and moving teeth. A tension of 15,000 volts is employed. Fessenden also employs a rotary disk apparatus, especially in the stations of the United States navy, with a tension of 12,500 or 25,000 volts.

The most important of recent improvements in methods derived from that of Poulsen have been introduced by Jeance and Colin, who have succeeded in establishing regular telephonic communication over unprecedented distances. These experimenters have ingeniously overcome the difficulties of the Poulsen method and utilized all of its advantages by producing the arc in an atmosphere of hydro-carbon vapors between a thin carbon pencil and a copper bowl cooled by circulation of water. The waste of the carbon pencil is exactly compensated by a deposit of carbon resulting from the dissociation of the hydrocarbons, and the operation is perfectly uniform when the apparatus has once been adjusted. Three arcs in series are used, with an aggregate tension of 700 volts.

Collins, in America, continues to use his arc of 2,500 or 5,000 volts, formed between two disks rotating in a transverse magnetic field, which elongates the arc by "blowing." Jeance and Colin reject this artifice, deeming that its only useful effect is to fix the arc at a definite point. The Collins process, with others invented by De Forest and Fessenden, have been submitted to the United States navy. Collins estimates that his method will satisfy the required conditions of operation over one hundred miles without regulation for five minutes. He is now making an exhaustive study of the phenomena of the electric arc, and experimenting with a new thermo-electric detector.

The Polyfrequenz Elektricitaets Gesellschaft, which is exploiting the Peukert patents; the Wireless Syndicate, proprietor of the processes of Lepel and Burnstyn, and the Gesellschaft fuer Drahtlose Telegraphie have described methods which appear to be very much alike, and to be founded upon a principle which was announced by Wien in 1907, viz., the employment of short sparks in a greatly damped circuit, connected inductively with a second circuit which has very little damping. The radiant energy, in the form of sustained waves, is furnished entirely by the secondary circuit.

For the regular operation of this system it is necessary, according to Peukert, to form the electrodes of difficultly fusible metals, strongly cooled. In the apparatus of the Polyfrequenz Company the electrodes are disks of pure electrolytic copper, silver on their opposing faces and placed close together in a box. If necessary, a drop of alcohol is introduced between the electrodes. The upper disk is movable. The electrodes may be cooled by water or air and may be revolved by an electric motor. In Peukert's apparatus the dielectric is usually air. Other inventors have tried mica but without success, as this mineral becomes an electrolyte after it has been used for some time. In Lepel's apparatus the disks are separated by paper. Hence they can be piled on each other, and an almost unlimited tension and power can be employed. Peukert, however, prefers to use a number of separate elements. With one element connected with a circuit furnishing direct current at 220 volts, or alternating current at a few hundred volts, it is possible to send messages more than one hundred miles. The Polyfrequenz Company seldom finds it necessary to use more than three elements. Direct or alternating current may be used indifferently. The alternating current possesses the advantage of yielding the required voltage more readily. According to Lepel, if direct current is used the electrodes should be of different metals (for example, the cathode of bronze and the anode of copper) and separated by a fraction of a millimeter.

From the above description it is evident that the new methods differ radically from the old ones, over which, according to their inventors, they have the marked advantage of making possible the employment of comparatively low tensions and greatly simplified inductance coils, condensers, keys, etc. The Polyfrequenz Company uses condensers insulated by sheets of paper. In the Lepel system sheets of mica are employed in the condensers.

Short spark generators possess a very high efficiency. The loss in transforming direct, or low-frequency, to high-frequency current is less than forty per cent. Hence the efficiency is at least four times that of Poulsen's method. These claims have been, in part, substantiated by experiments made independently of the exploiting companies. The consumption of energy is further reduced by the fact that the short spark is formed instantaneously.

II. *Reception of Waves.*—In the methods which employ sustained waves, direct reception by a telephone receiver is not possible, because the frequency is too great to produce an audible sound, and the waves do not form periodic trains, like the waves formed by the ordinary spark. The function of the instrument called the ticker, which was described in a previous article, is to interrupt these sustained waves in such a manner as to produce sound in the telephone. To dispense with the ticker is the object of the projections introduced in the disks of the Marconi apparatus, and of various devices employed by Balsillie, Fessenden, and others. It is desirable to eliminate this accessory in order that all stations may be able to communicate with each other, and it is largely because this desideratum is not satisfied by the Poulsen method that this method has met with much opposition and has not come into extensive use.

The ticker can be dispensed with when, as in the methods of Marconi, Balsillie, etc., an oscillating system is employed which produces waves of periodically varying amplitude. A simple method of satisfying this condition, which is used for important stations in the Peukert system, consists in employing an alternator of such a frequency, 500 cycles per second for example, that an audible sound is produced by the successive groups of waves.

In this case the telephone gives a musical sound, which is very agreeable to the ear and makes the signals clearly distinguishable from noises produced by disturbing influences. The same system is employed by Fessenden with the rotary interrupter. The discharging points are so arranged that they produce one discharge for each alternation of the current.

Rectifying and electrolytic receivers are still being studied. Jégou has devised an electrolytic receiver which requires no battery. For wireless telephony, thermo-electric detectors, and vacuum tube detectors based on the Edison effect, appear to find much favor. On the other hand, Rossi has constructed a very simple electro-magnetic receiver, a sort of bifilar Einthoven galvanometer, and De Forest has devised a multiple hysteresis detector, a modification of that of Marconi. Balsillie employs a similar apparatus which, he claims, is as sensitive as the best of the known receivers and is, at the same time, far less delicate and more regular in operation. Collins announces the completion of a thermo-electric detector sensitive to oscillations, the energy of which is only 1/5000 erg.

III. *Working Methods.*—The list of patents relating to wireless telegraphy contains a large proportion of patents for methods of operation. The outsider would be surprised by this diversity of methods proposed for what appears at first glance to be the simplest part of the problem; but practical workers in wireless telegraphy understand the importance of this feature. In the infancy of wireless telegraphy many practical difficulties were caused by imperfection in the transmitting apparatus.

With methods employing the arc, which is not formed instantaneously, it is impossible to control the circuit directly by the transmitting key. The general practice is to produce a continuous train of waves and to give the signals by modifying their frequency. Various devices have been invented for this purpose: Alternation of resistance and other electric constants, interruption of the current of hydrocarbon vapor in which the arc is formed, etc. The composition of the hydrocarbon mixture may also be varied. The employment of short sparks greatly simplifies the question, and this is an especial advantage of this method, in which it is necessary to generate waves only during the passage of each signal, instead of maintaining a continuous electric discharge. In Balsillie's system, as in ordinary telegraphy, the key acts directly on the transmitting current, and also serves as a commutator in passing from transmission to reception. For the arc system Peukert inserts the key as a shunt to the arcs. This produces regularity of operation, but diminishes the efficiency.

In wireless telephony there are various systems of influencing the radiations by the use of the microphone. In the simplest method, which has been adopted by De Forest, Fessenden, Poulsen, Majorana, and others, the microphone is intercalated in the circuit of the transmitting antenna, so as to vary the ohmic resistance of the circuit. This process, however, can be used only for communication over a very short distance with small power. For, with the exception of a few types which have not yet been introduced into practice, microphones, as now constructed, cannot well be used continuously with currents of more than one ampere.

In another method the microphone acts inductively on a coil inserted in the antenna circuit, but the variations of amplitude thus obtained are too small for long-distance transmission. The writer has suggested placing the microphone as a shunt to the battery. In this way a powerful current can be modified by means of an ordinary microphone, but this arrangement is not satisfactory in point of efficiency. Other systems have been devised by Fessenden, De Forest, Collins, and Majorana. Jeance and Colin employ a number of microphones containing no combustible matter, which are connected between the earth and a properly selected point of a Tesla coil connected with the antenna. The current which flows through this branch circuit is regulated by the insertion of a variable resistance, inductance, and capacity, so that its strength is one-tenth that of the main antenna circuit. Using instruments capable of supporting a current of 0.8 ampere, Jeance and Colin found no difficulty in modulating the electric energy required for telephonic transmission over a distance of 150 miles.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Revue des Sciences Pures et Appliquées.

The British consul at Vera Cruz reports that the fuel situation in a large part of Mexico, at the commencement of the last quarter of 1909, was decidedly serious, especially for the railway companies. Most of these had gone to considerable expense, changing the fireboxes of a large proportion of their engines from coal to oil consumers—contracts having been made in the anticipation of petroleum deposits discovered producing a constant supply of oil fuel. The oil companies, however, without notice, suddenly and very materially curtailed the supply of fuel oil, with the result that the railways, in many cases, found themselves without a sufficient stock of coal on hand to meet the shortage caused by the want of oil fuel. The situation should result in increased orders for British fuel.

THE IRON ORE RESOURCES OF THE WORLD.

HOW MUCH IRON IS THERE STILL LEFT?

IT is not long ago in the history of mining since a beginning was made, says the London Times, in estimating mines or mining districts. This was made necessary by technical and commercial reasons in order to confer upon the mining industry the requisite economic stability, and to decide how much capital might be invested in a deposit or to fix its price in the event of a transfer. As a result of the increased consumption of raw materials, which arose in connection with the enormous development of industry in modern times, questions as to the conservation of the raw materials produced in each country were called into existence; and for the same reason as it was found necessary for the individual mineowner to know the reserves of his mine, it was deemed necessary for whole countries to form estimates of the quantities of mineral products within their boundaries. Next to coal, iron ore is one of the most important mineral products.

THE STATISTICS OF IRON ORE SUPPLY.

Perhaps the very earliest attempt to calculate the resources of iron ore of any one country was made in Sweden in 1898. This investigation was undertaken because of the noticeable reduction of the resources of such ores, low in phosphorus, as the Swedish iron industry had until that time chiefly been using, and because the export of iron ore was then beginning on a large scale from Northern Sweden. In 1907, Prof. H. Sjögren laid before the British Association for the Advancement of Science, at their Leicester meeting, an estimate of the iron ore resources of the whole of the Scandinavian peninsula. But the most remarkable attempt to estimate iron ore resources was commenced in 1908, when a conference of governors of the different States as well as some experts met in Washington at the invitation of the President of the United States, Mr. Theodore Roosevelt, in order to consider measures for the conservation of the natural resources of the country. As a result of this, a National Conservation Commission was appointed in June, 1908, and this commission issued its report in January of the following year. Mr. Roosevelt then proposed to the governments of the different countries to send delegates to an international conference at The Hague to consider the establishment of an inventory of the world's natural resources and the adoption of measures against the mismanagement of those resources. It was thereupon decided to collect statistics relating to the iron-ore deposits of the respective countries and to present them at the Eleventh International Geological Congress to be held at Stockholm this year. A committee was appointed to deal with the statistics thus received, and to report thereon.

A TOTAL OF 22,500,000,000 TONS.

The figures obtained may be classified into three groups, the first including those deposits in which a reliable calculation of the extent of the deposit, based on actual investigations, had been carried out; the second covering such deposits in which only a very approximate estimate could be arrived at; and the third containing such deposits as could not be represented in figures. In all, 130,933,570 square kilometers (50,553,461 square miles) of territory were investigated; of this area, 13.3 per cent may be classed as belonging to the first group, 10.3 per cent to the second, and 51.6 per cent to the third, the remaining 24.8 per cent not being accessible for the inquiry. One of the most striking results of the collected reports is the fact that areas covered by the reports of the first group contain much greater quantities of known and recorded iron ores than is the case with those covered by the second group. The first group, which consists of the greater part of Europe and the United States of America and Japan, comprises 17,368,117 square kilometers (6,705,829 square miles); in this area, 7,020 million tons of actual and 49,295 million tons of potential resources are known of, the iron quotient—which is ascertained by dividing the quantity by the area—amounting to 404 for the actual and 2,838 for the potential resources. On the other hand, the corresponding figures for the second group show far lower iron quotients—viz., 225 for the actual and 261 for the potential ore resources.

The total amount of the known iron ore resources of the world are, actual, 22,408,000,000 tons, representing 10,192,000,000 tons of iron, and, potential, 123,377,000,000 tons, representing 53,136,000,000 tons of iron. As the production of pig iron at present can be put down at 60,000,000 tons yearly the supply of actual resources hitherto known would not be sufficient for 200 years on the supposition that the production of pig iron remained stationary. To what extent the future production of iron will become dependent upon low-grade ores, also upon the advance of technics, by which iron ores that are at present valueless, such as potential ore reserves, may be utilized, is obvious from the comparatively small remaining supplies of ores which contain more than 60 per cent of iron. Four-fifths of the known and recorded rich iron ores come from the deposits of Northern Sweden. In Europe the greatest actual ore reserves are the minette ores distributed between Germany, France, Luxemburg, and Belgium, amounting to about 1,850,000,000 tons of iron. Next in order of importance come the ore reserves of Northern Sweden with about 673,000,000 tons. Among the potential resources, the clay-ironstones of Great Britain, chiefly divided into two centers, one in England and Wales with 7,100,000,000 tons, the other in Scotland with 2,400,000,000 tons, are first. In North America the most important ore resources lie in the Lake Superior region, with about 2,000,000,000 tons actual and 36,000,000,000 potential reserves of iron. Next to these are the considerable deposits in Newfoundland, with about 1,960 million tons of actual reserves. In Cuba there are about 857,000,000 tons actual and 454,000,000 tons potential reserves. In South America only one single important iron ore center is known; this is situated in the Province of Minas Geraes, and contains at least 3,055,000,000 tons potential iron reserves. There are no definitely fixed iron ore centers in Africa, while in Asia and Africa no iron ore centers of any importance are known.

Nevertheless, too much importance must not be ascribed to the geological situation of the iron ore centers. The question as to where an iron industry is to develop will in each case be one of calculation, depending upon a great many factors, among which the presence of iron is only one. The other important factors are the supplies of fuel, facilities for smelting, cost of transport, possibilities of disposing of the products, etc.

POSITION OF THE UNITED KINGDOM.

With regard to the deposits in various countries, Prof. Henry Louis, who has reported upon Great Britain, points out that in the first place this country is for many reasons at a disadvantage compared with most other civilized countries in the matter of estimating its ore reserves. Owing to its extensive seaboard, the proximity of the chief seats of iron manufacture to the coast, and the large exports of coal, rendering return freights cheap and plentiful, the United Kingdom is exceptionally well situated for importing iron ores, and foreign ores can, therefore, enter so cheaply that they compete on highly favorable terms with native products, the result being that the latter are to a great extent disregarded, and are likely to remain so until the falling off in imported supplies shall again direct the attention of ironmasters to the ore reserves existing in their own country. Prof. Louis estimates the resources of the United Kingdom at 39,500,000,000 tons, which he classifies as follows: Stratified iron ores of the carboniferous formation, 34,000,000,000 tons; stratified iron ores of the secondary formations, 5,000,000,000 tons; and all other iron ores 500,000,000 tons. As the average iron contents of the total ores range from 30 to 35 per cent, the foregoing figures correspond to about 13,000,000,000 tons of iron. At the present time the United Kingdom produces about 15,000,000 tons of iron annually, equal to about 5,000,000 tons of metallic iron. It is thus obvious that the iron resources of the country are fully equal to all demands that the future can possibly make upon them if regard is merely had to quantity. But it must be pointed out that in these figures no attention has been paid to the question whether these ores can be worked with profit, and it may be said that by far the largest proportion of the above quantities cannot be profitably worked at the present time. It is, however, considered by no means impossible that some change in the conditions of the iron trade may render of commercial importance many of the ores which are useless to-day, seeing that the data given in the report are concerned with true iron ores—namely, such as contain at least 25 per cent of metallic iron.

ORE RESERVES IN FRANCE.

In France three classes of ore predominate—(1) minette ores in the Lorraine, (2) silurian ores in Normandy, and (3) ores occurring in the form of veins in the Eastern Pyrenees. The ores in the Lorraine district contain in some cases 42 per cent of iron, but generally the percentage of iron ranges between 33 and 40 per cent, the amount of phosphorus in these ores being from 1.7 to 1.9 per cent. The ore-bearing area is divided into certain basins, the most important of which are Nancy, Briey, Longwy, and La Crusnes, and the actual reserves of ores in these basins are about 3,000 million tons. The only considerable deposits of Bessemer ore in France lie in the Pyrenees. Taken altogether, the available ore reserves in France may, in round figures, be estimated at 3,300,000,000 tons.

RICH DEPOSITS OF SPAIN.

Spain may be considered as a country possessing considerable iron-ore reserves, the best known of which are situated near Bilbao. These deposits, however, are no longer the largest in the country, as 150 million tons of iron ore have been raised there in the course of 23 years, but there are still more than 61 million tons of iron ore left in Bilbao. In the province of Oviedo the ore reserves are estimated at 111 million tons. At Osjos Negros there are considerable deposits which have been calculated to contain about 93 million tons. The total quantity of ore reserves hitherto investigated in the whole of Spain are estimated at 711 million tons. The total ore reserves of Germany are estimated at 2,840 million tons actual and 1,067 million tons potential. With regard to Belgium, the most flourishing period of the iron industry seems to have been between 1854 and 1873, when the production of ore reached the average of 778,000 tons yearly. As a result of the crisis in 1873 it fell rapidly to about 200,000 tons, and has ever since remained stationary at this figure. Only one of the oolitic hematite deposits is still being mined, and this produced 35,000 tons in 1908. The minette basin in Luxemburg shows a production of 80,000 tons. The Belgian iron ores may be divided into (1) sedimentary, (2) fissure vein, and (3) recent surface formation. The estimated reserves of the first named are stated to be 50 million tons; of the second, which contain 45 per cent of iron and a low percentage of phosphorus, five million tons are estimated to be available, while 7½ million tons of recent surface formations might also be worked, giving a total of the reserves of ore of Belgium as 62½ million tons.

BRITISH INDIA AND THE EAST.

As regards British India, Sir Thomas H. Holland reports that two groups of ore bodies, composed of rich hematite, have been examined more carefully than other deposits. They contain 500 million tons, and may include much more. There are numerous bands of quartz-hematite and quartz-magnetite schists and various occurrences of hematite, but no estimate of quantity has been formed. The only abundant supply of clay ironstone has already been largely worked and may be approaching exhaustion. The superficial deposits of ferruginous laterite are very lean ores, and cannot be regarded as serious reserves. The iron ore reserves of Asia, apart from India, are 260 million tons, 100 million tons of which are credited to China and 55 million tons to Japan.

CANADA AND SOUTH AMERICA.

No attempt seems to have been made to give any estimate of the known resources of Canada. The ore still remaining on Great Bell Island is about 12 million tons, and that in the submarine area under Conception Bay about 3,522 million tons, while with respect to other deposits, of which no reliable data can be discovered, the total certainly runs into many hundreds of millions of tons.

The actual reserves of the United States are estimated to be 4,257 million tons, and the potential reserves are calculated as 75,105 million tons, the bulk of which lies in the Lake Superior region. As regards the future, the ores of 60 per cent and above, except as concentrates, are a rapidly vanishing reserve; but of ores of 50 per cent there is a sufficient supply for many years, while of 40 per cent material the reserves are practically inexhaustible. The potential reserves of Brazil have been calculated to contain some 5,710 million tons of ore, but this is probably a low estimate, which will be multiplied several times over when the country has been fully examined.

No estimates are made of the iron-ore deposits of the Transvaal or Cape Colony, but it is well known that few countries can show so many and such enormous deposits as the Transvaal, although none of them have so far been worked. The only deposits known in Cape Colony are to be found in connection with the Lower Griqua Town beds in Griqualand West and Bechuanaland.

Pressure filters placed direct on the mains, are in use by the Krugersdorp Municipality, South Africa, which obtains its supply from a reservoir in which the water, during heavy rains, becomes highly discolored. The filters are of the Candy type, according to the Surveyor. Each is 7 feet in diameter, has a capacity of 6,000 gallons per hour, and operates under a head of approximately 70 feet.

ELECTRICAL NOTES.

The electric railway between St. Polten and Gusswerk is the first European narrow gage single-phase line. The gage is 30 inches and the line is 55 miles long. The works were difficult, as there are no less than sixteen tunnels, one a mile and a half long, and fifteen short ones, the collective length of which is one mile. The sharpest curve is 100 yards radius and the steepest incline 1 in 40. The current is derived from three separate stations, one of which, however, is kept as a reserve, and supplied to the locomotives from an overhead wire. Each locomotive weighs 30 tons, has two 250 horse-power motors, and can take a train weighing 150 tons up a bank of 1 in 40 at a speed of 18 miles per hour.

The author of an article in the Electrical World strongly recommends the use of accumulator locomotives where products have to be moved from one part of a works to another. Particulars are given of locomotives suitable for this purpose. The track should be laid with curves not less than 40 feet radius. For pure inter-shop service a small 2.5-ton locomotive is convenient. For obvious reasons care should be taken to select series motors that are not too large for the work, and it is well to have two motors with knife switches to throw in both for heavy work, one motor alone being used for the lighter work. Success depends upon proper size of and attention to the battery. The author gives an account of his experience with such locomotives.

It is estimated that there are not less than 800 amateur wireless telegraph stations in Chicago. This figure, which has been made on a conservative basis, includes the total present number of active, dormant, and neglected outfits in which the interest of their generally youthful owners is at various degrees of intensity. It numbers equipments ranging from the ½ inch spark coils of beginners up to the high-powered stations of advanced amateurs, which are, in all respects, equivalent to the commercial outfits. In addition to the amateurs, there are three wireless telegraph companies having stations in Chicago—the United Wireless Telegraph Company, the Great Lakes Radio-Wireless Company, and the Continental Consolidated Wireless Company. The first-named concern does a commercial business with its chain of wireless stations on the shores of the Great Lakes, and with 65 vessels equipped with its apparatus.

A note in the Electrician refers to a 20-kilowatt 200,000-volt testing transformer which students in the electrical engineering school of Purdue University have recently completed, under the direction of Profs. C. F. Harding and J. W. Esterline. The material used in building this apparatus was part of that employed in the famous "million volt" transformer exhibited at the Louisiana Purchase Exhibition at St. Louis in 1904, and afterward acquired by Purdue University. The reconstructed transformer is air-insulated, and measures over all 76 inches by 55 inches. The rectangular core is 10 inches by 5¼ inches in section, and the magnetic circuit has a main length of 222 inches. The 110-volt primary winding comprises 38 turns of No. 4-0 stranded copper cable. The secondary winding is made up of 76,000 turns of No. 30 silk-covered wire, having a total resistance of 68,000 ohms. The magnetizing current is 22.6 amperes, having a power component of 16.1 amperes. The transformer is to be used for research study in high-tension phenomena.

Barges filled with stone and sand are now unloaded at the Gatun Docks by means of searchlights. There are one single and two duplex cableways for unloading sand and rock, and one searchlight for each cable has been placed on the tail towers, casting a light along the cables, on the barges at the dock and over the storage piles. The searchlights are 18 inches standard Navy projectors, and are operated by a motor generator which converts current supplied at 600 volts from the power plant to current at 125 volts for the lamps. The lights are controlled from the head or operating towers. In addition to the searchlights, strings of flame arc lamps have been stretched from the head towers to the tail towers, four lamps for each tower. These lamps form their arc at the apex of an acute angle made by the carbons, and therefore throw a light equally in all directions. On this account, although they are strung below the level of the cables, they illuminate them as well as the storage piles beneath.

In an article on the renewal of sulphated storage cells, reproduced from the Electrical World in the Electrical Review, Mr. J. O. Hamilton describes a method of dealing with such cells which has proved very successful at the Kansas State College. If, on test, the efficiency of a cell sinks to 50 per cent, or lower, the plates are removed and washed thoroughly with distilled water. They are then placed in a cell containing a 2 to 5 per cent solution of caustic soda in water, and the charging current sent through the cell in the usual way. If the sulphate on the positive plate does not disappear during the time of the ordinary charge, and the solution gives an acid reaction with litmus paper, more caustic soda must be added to the solution, and the charging continued until the plate has the usual chocolate appearance. The plates should then be removed from the soda solution, well washed, replaced in the sulphuric acid solution, and the charging continued until gassing begins. Many cells have had their efficiencies raised from 25 to 75 per cent by six hours' charge, and Mr. Hamilton considers that any cell which will still hold together will well repay treatment by this method.

ENGINEERING NOTES.

Bulletin No. 40 of the Engineering Experimental Station of the University of Illinois consists of an account of measurements made by Messrs. J. K. Clement and C. M. Garland of the heat transmitted through a steel tube of 1¼ inches external diameter, with walls ⅛ inch thick, from steam outside to water inside running through the tube. The temperature of the outside surface of the tube was measured at two points by means of thermo junctions of copper-constantan placed in small holes drilled in the tube. The temperatures of the incoming and outgoing water, and of the steam, were determined by mercury thermometers. Curves are given showing the variation of the heat transmitted with the velocity of the stream of water, and with the temperature of the steam, and the resistance to the transmission of heat is shown to be almost entirely concentrated in the films of stagnant steam and water in contact with the surfaces of the steel tube. The authors regard the present communication, not as one devoted to new facts, but as a demonstration of the utility of their method of measurement, and propose to apply the method to the investigation of problems connected with steam boilers.

Some anomalous effects of first loading a wire are discussed in the Philosophical Magazine by A. I. Steven. The so-called anomalies are only special cases of the loss of elasticity consequent upon severe overstrain, and the author concludes that any theory which explains one type of effect will be equally applicable to this one. Every wire after manufacture is subjected to non-homogeneous overstrain by being wound on a circular bobbin of comparatively small dimensions. It is probable that, if the wire remains on the bobbin, part of the internal stress disappears before the wire is tested. When the wire is wound off the bobbin for testing another set of stresses is superposed. The processes of bending and unbending do not exactly neutralize each other. In the experiments, soft iron wire was used, of average diameter 0.0364 centimeter. Extension of length was measured by two microscopes. Load extension curves given show effect of three successive tests on wire. The same type of curve always resulted (with cylinders of four different diameters) when a wire suffered circular deformation. Other tests show the similarity between behavior of wire and iron and steel rods after overstrain. Tests on overstrained wires subjected to low heat treatment showed slight variation to similar tests made on steel bars.

CONCRETE
REINFORCED CONCRETE and CONCRETE BUILDING BLOCKS

Scientific American Supplement 1543 contains an article on Concrete, by Bryson Cunningham. The article clearly describes the proper composition and mixture of concrete and gives results of elaborate tests.

Scientific American Supplement 1538 gives the proportion of gravel and sand to be used in concrete.

Scientific American Supplements 1567, 1568, 1569, 1570, and **1571** contain an elaborate discussion by Lieut. Henry J. Jones of the various systems of reinforcing concrete, concrete construction, and their applications. These articles constitute a splendid text book on the subject of reinforced concrete. Nothing better has been published.

Scientific American Supplement 937 contains an article by Spencer Newberry in which practical notes on the proper preparation of concrete are given.

Scientific American Supplements 1568 and **1569** present a helpful account of the making of concrete blocks by Spencer Newberry.

Scientific American Supplement 1534 gives a critical review of the engineering value of reinforced concrete.

Scientific American Supplements 1547 and **1548** give a resume in which the various systems of reinforced concrete construction are discussed and illustrated.

Scientific American Supplement 1564 contains an article by Lewis A. Hicks, in which the merits and defects of reinforced concrete are analyzed.

Scientific American Supplement 1551 contains the principles of reinforced concrete with some practical illustrations by Walter Loring Webb.

Scientific American Supplement 1573 contains an article by Louis H. Gibson on the principles of success in concrete block manufacture, illustrated.

Scientific American Supplement 1574 discusses steel for reinforced concrete.

Scientific American Supplements 1575, 1576, and **1577** contain a paper by Philip L. Wormley, Jr., on cement mortar and concrete, their preparation and use for farm purposes. The paper exhaustively discusses the making of mortar and concrete, depositing of concrete, facing concrete, wood forms, concrete sidewalks, details of construction of reinforced concrete posts.

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SCIENCE NOTES.

The action of ultra-violet light upon gelatine is brought out by A. Tian, of Paris. It is well known that bichromated gelatine and albumen are modified by the action of ordinary light, and recent researches show that pure egg albumen is coagulated by ultra-violet light. The author wished to find the effect of the rays upon gelatine and he used the pure gelatine of commerce for the tests, working with a quartz mercury vapor lamp which gave the ultra-violet rays. The matter to be tested was placed in a vessel having a transparent quartz cover on the top, and the whole was immersed in water at a constant temperature. He finds that dry gelatine is not affected by the rays. Using the gelatine in the form of a jelly, and exposing it for 10 minutes at a distance of 6 inches from the lamp, the surface is found to be liquefied. Here the temperature is from 5 to 23 deg. C. The action is more strongly marked when the preparation is in a less concentrated form, but the effect appears to take place in all cases only at the surface, this being no doubt due to the opacity of the gelatine for the rays so that they cannot penetrate into the mass. Using a stream of water, the liquefied surface is carried off as soon as it is formed, so that the gelatine is dissolved off continuously in this case. In less than an hour we can clean off a photographic gelatine plate in the transparent parts, and a depression can be already seen in one minute. The action is not due to heat, as was proved, and is due to the ultra-violet rays alone, seeing that placing a glass or mica screen between will stop the action. The present phenomenon may have a practical value for treating photographic plates. We can obtain a plate in relief from an ordinary plate, and can also weaken a thick plate to any desired point.

In a paper presented to the Academie des Sciences, M. A. Lacroix gives an account of the action of sea-water upon metallic objects of antiquity, as seen in Roman objects found off the coast of Tunisia. Here were found the remains of a vessel which probably came from Greece on its way to Rome, containing marble columns, statuary and bronze objects. The date is the first half of the first century B. C. As to the action of so many centuries immersion in sea-water, the author observed specially the specimens of lead and copper. The first specimen was a sheet of lead, and only the surface was attacked. Unfolding the sheet in some places, there appeared white and sometimes transparent crystals which are the same as the natural chloride of lead known as *cotunnite*. Almost the only source of this mineral is the fumeroles of Vesuvius. It is also said to be found at Tarapaca, Chile. As regards copper, he observed the hollow head of a copper nail and the hollow formed a geode-like cavity, being lined with crystals. These are brilliant transparent crystals of *phosgenite* Ph CO_3 Pb Cl_2. The body of the nail, which was 4 inches long, was transformed to sulphide and had a portion of the wood adhering to it. The predominant mineral is *covellite*, Cu S, which has an indigo blue color and a metallic luster. In general there is a mixture of this mineral with chalcosite, Cu_2 S. Such action has been already observed in the case of hot springs, as the Romans had the custom of throwing coins into the springs as an offering to the divinity. When such coins are taken out they are observed to be transformed to sulphide in many cases. It was thought that the hydrogen sulphide gas of the springs was the cause of this action, but the present research shows that organic matter alone can produce the same effect.

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